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Do You Know 290

Conference Papers and Addresses

Engineering for Mathematicians — C. O. Oakley 292
Role of Nuclear Courses in Engineering — V. L. Parsegian 296
Industry's Responsibility for Developing Teachers — R. C. Smith 301
Curriculum in Petroleum Production — E. T. Guerrero, R. L. Langenheim 304
Industry Conditions Attracting the Teacher — R. N. Dyer 310
Why Industry Likes the Co-Op — C. F. Arnold 314

Mechanics Division Papers

Mechanics Bulletin: Chairman's Message — F. J. McCormick 320
People and Technical Progress — W. H. Crew 321
Continuity in English for Training Engineers — J. A. Walter 323
Continuity in Presentation of Mathematics — J. W. Cell 326
Continuity in Organizing Engineering Data — W. S. Hill 328
Uniform Mechanics Examination — S. B. Folk 331

Departments

YET-itude: Teaching and Psychodynamics — T. P. Goodman 334
Creativity and Engineering Education — H. L. Shulman 336
Graphic Science: Engineering Drawing Division Midwinter Meeting 341
Drawing for Tomorrow — B. L. Wellman 343
Teaching Positions Available 347 New Members of ASEE 349

Reports

Minutes of the Executive Board (October 26, 1956) 357
Minutes of the General Council (October 27, 1956) 361

Notes

Air Force Academy 309 Van Houten to A-C-E 342
Floe Vice-Chancellor 342 College-Industry Agenda 355
ASEE Reprints 356 Aero Division Meeting 360
ECRC Officers 382 Calendar of Events 384

DO YOU KNOW . . . .

▶ . . . . That the General Electric Company is modifying its summer program to provide training for YETs? G.E. will employ the group for the summer, but during the last two weeks, they will be "spirited away" to a secluded spot for two weeks of specialized study and discussion of effective teaching. The proposal of the YET Committee for a Summer Institute was so expensive that the Executive Board requested further study and revision. That is why G.E. developed the program just described for the summer of 1957; they want to supplement and assist, not compete with any YET plans.

▶ . . . . That the next major study of the Society will be on the Procurement and Development of College Faculties to meet future instructional needs? President W. L. Everitt believes this is the biggest problem confronting engineering education in the next ten years. There is reason to believe emphasis no longer needs to be primarily on numbers of students, though quality still should be stressed. The real emergency current demand is for an adequate supply of good teachers. Harold L. Hazen, Dean of the Graduate School, Massachusetts Institute of Technology, has agreed to serve as chairman, and a "top flight" advisory group is being assembled to formulate plans and a budget. A working committee or committees will then be appointed. It is expected that foundation funds will be available.

▶ . . . . That the Mid-winter meeting of the Cooperative Education Division will be held in Boston on January 10 and 11? Northeastern University is the host and R. L. Woolridge, Director of Cooperative Work for Northeastern, is in charge of the program. The general theme of the program is industry-co-op problems.

▶ . . . . That in order to "catch up" and bring the JOURNAL out on time, we have "doubled up" on operations, so that this issue utilizes supplementary printing facilities? It now looks as though the flow of manuscripts is such that the Editor can get material prepared on time, but on a tight schedule printing two issues in one month has proved to be a problem. We are therefore taking drastic measures to extend capacity.

Even if we are lucky enough to get off the siding and back on the main line, everyone's help will still be needed, particularly from program chairmen for Sectional meetings, Mid-winter meetings, and the Annual Meeting. *They* are responsible for seeing that two copies of papers and other materials, double spaced, are submitted to the Editor or to the Secretary's office three months in advance of the publication date. If chairmen don't insist on authors submitting papers and don't see that usable copy is supplied early for publication, there is little that the Editor or Secretary can do. Recommendations as to quality, relative importance, priority, and optimum length are also desirable.

▶ . . . . That if you have nominations for any of the *four* major Society awards — Lamme, Bendix Research, Westinghouse, or McGraw Research — this is just about your last opportunity

to do something about them? The information sheets and nominating forms have been distributed. If you can't get one elsewhere, write to the Secretary.

▶ . . . . That the 1959 Annual Meeting will be at Pittsburgh, Pa. instead of at Purdue University? The city of Pittsburgh is celebrating its 200th anniversary in 1959, and the Allegheny Section, including Carnegie Institute of Technology and the University of Pittsburgh, desired to serve as hosts for the Annual Meeting that year. Although a firm agreement had been reached with Purdue University for 1959, Purdue most graciously withdrew their invitation provided they could be the hosts in 1960. That has been agreed to and there will be no further changes for 1960! The exact dates will be announced as soon as they are available.

▶ . . . . That the Local Committee at Cornell is working hard on the plans for the 1957 Annual Meeting? The same is true of many of the Divisions. The material for the Preliminary Program must be in the Secretary's office by February 1. If you suspect your Division or Committee is lagging, please give it a boost. Also, don't forget to complete your own plans for attending and remember, **ASEE Annual Meeting, Cornell University, Ithaca, New York.** Wonderful vacation land, too!

▶ . . . . That plans for the million-dollar survey of the engineering profession are progressing? The joint ECPD-EJC committee has submitted its report, and the constituent societies now are appropriating funds to initiate plans and present a proposal to interested foundations. The Executive Board of ASEE has authorized an expenditure of up to $1,000 as the Society's fair share of the initially required $50,000. Other member groups have taken and are taking similar action.

▶ . . . . That Engineers Joint Council is issuing a one-page newsletter? The first issue came out in October. It is named *Engineer* and is EJC's report on what's happening in engineering. It is being mailed to Board members of constituent societies, chairmen of local sections of constituent societies, editors of trade publications, chairmen of local engineering societies, and editors of constituent society publications. This should prove to be a valuable means of disseminating to the engineering profession as a whole a general knowledge of EJC Board and Committee Actions.

It may be well to repeat, in this connection, that the third EJC Annual Assembly will be held at the Statler Hotel in New York City on January 17 and 18, 1957.

▶ . . . . That ASEE isn't always behind the times? Our Relations With Industry Division was established in 1946, and has been an important unit of the Society ever since. Other educational organizations are just now becoming cognizant of what ASEE realized ten years ago, as is evidenced by the following resolution of the American Council on Education: "Whereas the American Council on Education, both by canvassing its constituent and associate members and by discussion at its 1956 annual meeting, has found needs not at present fully met in the area of strengthening mutual understanding and cooperation between education and business and industry; and "Whereas we believe that, in the years ahead, education will have an increasing obligation to understand and be

(continued on p. 319)

ENGINEERING FOR MATHEMATICIANS

C. O. OAKLEY

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Address of the retiring chairman of the Mathematics Division presented at the Division Luncheon on June 26, 1956, Ames, Iowa.

In his retiring address as Chairman, Mathematics Division, (JOURNAL, Oct., 1955, pp. 115-120,) Dr. Richard Burington went on record as "advocating strongly a 'new look' at the philosophy of educating mathematicians in our mathematics departments." His remarks were addressed primarily to graduate schools when he said we should establish two major mathematical programs, one the "traditional graduate school training, with principal emphasis upon training for research in a highly specialized atmosphere," and another one pointed toward "a professional career with appropriate training and experience." Dr. Burington made a strong plea that "it is these mathematicians who our universities must train, not only those for a life of teaching and academic research, but also those for a life of industrial research and development work in government and industry."

These are important objectives and, in passing on to my own subject, I wish to lend support to them. When we look about us at the great shortage of technical and scientific personnel, it is clear that something should be done about this matter.

My own immediate concern, namely the undergraduate mathematical training of engineers, is not wholly unrelated to the suggested program of Dr. Burington. The connection should be quite apparent as I state my main thesis: Mathematicians who have had little or no scientific training outside of pure mathematics are not in the most favorable position to train engineers.

Before proceeding with this theme, however, I want to discuss the attendant problem of what mathematics should be given to undergraduate engineers. Most of us feel we are so familiar with this question that we pay too little attention to it. As a matter of fact, our familiarity has bred some contempt; we teach our mathematics courses for engineers year in and year out with little or no modification and without due regard for the changes that are taking place in this modern scientific world.

It is still algebra, some trigonometry, analytic geometry, calculus and, in some cases, differential equations. Algebra is important; we should give more, especially of the linear type. Analytic trigonometry is important and it is desirable to review this even for those students who use credit in trigonometry for admission. I am glad to say less and less attention is being paid to solution of triangles by logarithms. If you must teach solution of triangles, stick to the laws of sines and cosines and use a desk calculator. Enough analytic geometry

can be taught as it is needed in the calculus. Engineers do not need a course in conic sections although many departments of mathematics still treat this topic at great length. It may seem surprising, but many able mathematicians who are charged with teaching engineers feel that most of the time spent on analytic geometry is wasted.

But the greatest loss in time is in teaching calculus. Books on calculus are getting thicker and thicker, and for some unknown reason teachers think that they must cover more and more material; thus calculus often is given for three semesters. Engineers simply do not need this much calculus. The ideas of differentiation and integration are important, but they can be taught in a few weeks. Engineering students should learn very early how to use a table of integrals and there is a growing feeling that a special table should be prepared with this in mind. Proliferation of applications is neither necessary nor desirable. A semester or a semester and a half is enough to spend on calculus since there are more important topics that should be studied in the first two years.

The engineers' program is very tight and it is unrealistic to think they can spend much more than two undergraduate years taking courses in mathematics. I was sorry to read in the Report on Evaluation of Engineering Education recently issued by ASEE that the total time an engineering student can spend on the basic sciences of mathematics, physics, and chemistry, is about one-fourth of the undergraduate program. In my estimation this is not enough. Basic sciences are indeed basic.

So long as this report is followed, we can look forward to about two years in which we shall be giving the engineer all the mathematics that he will be taking as an undergraduate. It is true the electrical engineer usually gets at least another semester, and some institutions require a full third year of mathematics. This gives considerable time to spend on differential equations and other topics. Some schools work in at least a short course in differential equations during the sophomore year.

What Mathematics?

With all too little time before us, it is pertinent to ask ourselves just *what* mathematics we should be giving to engineers. This is not the place to present a detailed new curriculum, but I submit that topics such as matrix theory and linear and Boolean algebras might well be considered as appropriate material to substitute for some analytic geometry and calculus now offered.

Finally, before leaving this subject of mathematics for engineers, it is important to suggest that the material we do give be modernized. I shall mention only one item, that of the definition of a function. If you ask any young Ph.D. what a function is, he is almost certain to say that a function is a set of ordered pairs such that no two ordered pairs have the same first element. It is well to consider the sharpness of this definition along with the several older definitions still current in textbooks. Although the concept of *set* is playing a dominant role in both the structure and language of modern mathematics, how many of us teach in these terms?

The March, 1956 issue of the JOURNAL carried an article by F. Virginia Rohde and the report of the Pasadena Conference on Mathematics in Engineering, both of which I recommend.

Virginia Rohde points out that engineers are obviously dissatisfied with our

mathematical offerings. The fact that there is a strong trend in departments of engineering to develop their own courses in mathematics rather than to continue the traditional practice of leaving the matter in the hands of the departments of mathematics is concrete evidence of dissatisfaction and is sufficient reason for our deep concern, if not alarm. I can name several institutions that have Ph.D. mathematicians with engineering training who are teaching, within the engineering department, the mathematics courses. We must get together with the engineer and talk over these areas of mutual concern. One result, I am confident, will be a thorough overhauling of the kind of mathematics we are now offering to undergraduate engineers.

The changes in mathematical curricula that may result from such joint action will undoubtedly improve the situation, but they will not solve the problem completely. We face a still greater problem. This is the critical difficulty presented to us by the recent tremendous advances in science and technology in general.

To appreciate this change and to see it in proper perspective, we should give at least a thumbnail sketch of undergraduate engineering in mathematics up to about the time of World War II. At that time we needed to know only a very modest amount of physical science in order to give the engineers a reasonable list of applications that we ourselves understood. In college algebra, trigonometry, and analytic geometry, the engineering applications were very elementary and this is still essentially the case. Even in calculus most of the engineering applications were in the realm of physics and mechanics. Differential equations had some applications in the fields of biology and physical chemistry as well as in physics and mechanics, but all of these were quite classical in nature.

It is my impression, however, that teachers of mathematics are paying too little attention to the newer and modern applications, and this is also the contention of Virginia Rohde. So many new applications are now available in the area of calculus that I am sure we are far behind the times in our teaching. To mention just one example, it is clear that the engineer of today needs to know something about continuous probability. We have a perfect opportunity to introduce this material when we take up the problem of moments. I contend the idea of a standard deviation is as important as the radius of gyration ever was.

Our ideas of what is adequate for engineers in the field of differential equations must be considerably revised in view of the new electrical circuit theories and the existence of modern computers. Heretofore we have solved a few types of equations in closed form, but now we must thoroughly explore numerical methods of solving other types — actually those in which the engineer is most often interested. On more than one occasion an engineer has remarked to me that the problems preferred by most "pure" mathematicians were for the most part of little interest to him, while the ones with which he had to work were just the ones the mathematicians could not solve. With machine methods and machines available, this situation can be remedied.

If we have not included more modern engineering in our mathematics, it is because we do not know much about modern science and engineering. We have now entered into a new era of science. This is the age of the atom and

the amount of new science and engineering developed in the last two decades is fabulous. This means that those of us who received our graduate training before, say, 1936, are out of date.

Even though we may have taken considerable work on the side in the physical sciences, much of what we studied is no longer as important as some of the recent material. I have the impression that most graduate students in mathematics now spend practically all of their time on mathematics and little if any time in the physical sciences, with the exception of the very few who receive their degree in applied mathematics. Moreover, the mathematical topics themselves are of the pure rather than the applied sort. To my thinking this means that these young people, well trained in abstract mathematics though they may be, are not adequately prepared to teach engineers. It is no wonder departments of engineering are so disturbed that they are taking over the mathematical training of their students.

Personally, I have felt reasonably well prepared to teach engineers. As an undergraduate I earned a degree in electrical engineering. Furthermore, I had a profitable year of engineering practice with the Bell Telephone Laboratories. Later, as a graduate student in mathematics, I took a minor in physics. And yet I look back upon my training and it comes as a shock to me when I realize that all of my electrical circuit theory was done without a single vacuum tube! I am the first to admit that to do a first-class job in today's classroom I should have some more training in modern engineering methods and practices.

It will inevitably be a long time before the universities adopt any such plan as that outlined by Dr. Burington. If such a plan were adopted, it would insure a steady flow of mathematicians with sound engineering backgrounds who could then form a solid core of teachers in mathematics for engineers. There is so much of modern engineering that should be in mathematical courses that I see no other way of incorporating it into our existing offerings. And unless we do do something like this, we shall see our mathematical courses taken over by the departments of engineering themselves. Although I admit that I have a vested interest, I cannot believe that this would be the best solution to the problem.

I should like to make a suggestion that, if followed, could be of considerable value in getting more engineering into our present mathematical courses. It is similar to the plan of the social scientists who, sponsored in part by the Social Science Research Council, have held summer seminars to help train social scientists in mathematics. It would complement the Michigan Conference on Mathematics in Engineering held under the auspices of the National Science Foundation and the ASEE.

I should like to see a summer seminar devoted to the training of mathematicians in the fields of engineering. With engineers and mathematicians working jointly toward the common goal of improving their mathematical offerings, a six-week summer session could be highly beneficial both to the participants *and* to future students. I suggest that the Electrical Engineering and Mathematics Divisions of ASEE explore the possibilities. Perhaps support for such a seminar could be found in our own organization and the National Science Foundation.

THE ROLE OF NUCLEAR COURSES IN ENGINEERING CURRICULA

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A paper presented at the Chemical Engineering Conference, 64th Annual Meeting, June 26, 1956, Ames, Iowa.

The major technical problems posed by nuclear power systems are responsible for many of the advanced research programs that are underway in physics, mathematics, chemistry, biology, metallurgy, chemical engineering, electrical engineering, mechanical engineering, and other disciplines.

For example, the development of electronic computing machines and mathematical techniques is probably receiving its greatest pressure and support from problems associated with atomic power. The research program now under way to seek energy through fusion of light atoms has posed difficult problems involving electromagnetic phenomena, electrodynamics, and mechanical designs of vacuum systems.

The design of integrated nuclear reactor systems and associated fuel reprocessing plants are the most complex which the chemical engineers have had to face. The heat transfer loops of reactors and the problems of thermal stress are particularly difficult to analyze; here one must assure not only a much higher factor of safety against failure than is required of most nonnuclear systems, but must do this despite very severe restrictions on the choice of construction materials, for reasons of neutron economy and damage from nuclear bombardment.

Neutrons are precious and important modern materials, and their conservation and efficient use constitute the controlling considerations in the choice of materials and of reactor design. It is likely that neutrons, along with other nuclear radiation, may also become important for industrial processing. It would seem, therefore, that engineers should become more familiar with these important new tools.

Atomic power has also brought some of the most powerful research techniques that we have known. For example, while nuclear reactors have imposed very severe demands on the metallurgical engineer for new alloys and fabrication techniques to withstand the punishment of nuclear bombardment, the modern metallurgist has also had the benefit of powerful new research tools in the form of radioactive isotopes and of bombardment by nuclear radiation with which to pursue his study of metal systems.

The chemist and chemical engineer have been called on to produce large quantities of materials having unusual purity requirements, where impurities are measured in parts per million. The

fission of uranium produces very many dozens of product atoms, covering the whole middle half of the atomic chart around the rare earth region. Their separation chemistry is difficult. The atomic chart is no longer a simple system of 92 relatively static elements, but one which has suddenly blossomed into a magnificent dynamic system comprising many hundreds of elements, each having its own combination of chemical and nuclear properties. The whole picture is complex, but these new radioactive isotopes also provide the most powerful and sensitive techniques known to man with which to pursue the secrets of physical, chemical, and biological systems.

This then is the framework within which we are considering the role of nuclear studies in engineering education. It suggests that this major technology has its roots, and the elements that will help its growth, inseparably interwoven with the whole spectrum of professional subdivisions as we now know them.

One immediate reaction to this picture is the thought that to look on nuclear engineering as a separate professional division, as a further specialization beyond the existing subdivisions, may impose undesirable barriers that will impede its progress.

Basic Nuclear Training

In this connection it is well to look at the composition of the technical teams that are engaged on the major government and industrial atomic power programs. These teams include chemists, physicists, metallurgists, and almost every type of engineer. Some of them may also be called "nuclear engineers," whatever that means.

What is the core of experience and training which is common to the men on these teams? For example, what has the metallurgist of such a team in common with the chemists, the chemical engineers, the physicists, or even the "nuclear engineers"? Not much!

It is true that such team-mates must all be aware of the nature of reactor systems, and of the limitations that govern such systems. Each must be familiar with a certain range of basic nuclear information. We might call this the common background in nuclear energy. Beyond that, the manager of such a team must assign to the metallurgist the work for which he was trained as a metallurgist, and to the others the kind of work each was trained to do. I am puzzled, however, as to the work he would assign to the man who was graduated as a "nuclear engineer." Would he ask him to solve some mathematical or physical problems on neutron flux distribution in a reactor, some problem in fission product separation chemistry, to develop a uranium alloy phase diagram, to design a special pump, to compute the thermal stresses in the reactor structure, or to develop an electrical analogue system? I do not know.

There is also a second thought which is suggested by the extensive interrelationship between the atomic program and the various disciplines, namely that the atomic program is likely to be the most important of the factors that will determine the pattern of engineering education for the next few decades. It is important, therefore, that the organizational lines help to promote this benefit by keeping the nuclear teaching and research operations very close to the work of the various science and engineering departments rather than as a separate operation.

Nuclear Science Background

There is need to define more clearly the common background of training which appears to be necessary to those who are engaged in nuclear work.

I should like to begin with the standard atomic chart, and attempt to help the student in achieving some kind of physical picture of the orbital shell structure, and of the binding energies that are involved. I would not worry too much if he missed the historical development and the long equations of the quantum theory or of the relativity theory, but would consider it unfortunate if the engineering student could not explain in his own words the electronic "jumps" and relate them to the energy of the emitted or absorbed light.

Next would come the nucleus of the atom, and the charts that give the full list of nuclides. I should like to note that nuclear physics and nuclear chemistry need to be difficult only to the physicist and to the radiochemist; the engineer needs to have much less difficulty with them since he seeks a physical picture which is useful and only approximately true.

The simple picture of the unstable nucleus, and the laws that describe the statistical behavior of nuclear decay are not difficult to learn. The particles of nuclear structure and of nuclear emission need to be compared both as to their physical characteristics and in transmission through matter.

The subject of interaction of nuclear radiation with matter, and the various nuclear cross sections or probability for nuclear interactions, will require rather extended treatment. Much of it can be treated by describing transmission and attenuation phenomena in the mass, including diffusion characteristics.

I feel that the understanding of behavior in the mass would be insufficient if the student could not also visualize the interactions of the individual particles. The mass-energy equivalence, and its use in calculations involving nuclear transformation and nuclear fission, must be reasonably well established. The products of fission, and the nature of the prompt and delayed neutrons that are emitted, might complete this portion, which might be called the basic atomic and nuclear physics portion of the common background for cooperation.

Actually, there is little that has been described in this portion which ought not to be in the background of every technical man, whether applying his professional interests to the nuclear field or not. I am of the opinion that the chemists, and particularly the physicists, have been guilty of giving the student too much of the historic struggles of the past generations, and too little that the student can associate with the marvelous innovations of his own generation.

I have the further feeling that the physicist has been too prone to give second place to the teaching of atomic phenomena in the basic courses to engineers. This may have been tolerable in the age before nuclear power, but it can no longer be tolerated in the nuclear age. I should in fact attempt to introduce physics with the atom, since almost everyone is persuaded that matter is made up of atoms!

There is another aspect to this which has to do with the cultural aspects of atomic phenomena. At the present time engineers are particularly sensitive, and quite properly so, about the need for emphasis on the humanities in their curricula. I submit that there is also much cultural and philosophic value to

be derived from the amazing principles that are the foundation of atomic physics, such as the quantum theory and the relativity theory, which have unfortunately been largely lost to the engineer in favor of things he can handle with his hands and observe with his own eyes.

Nuclear Engineering Courses

In addition to nuclear science, there are several other areas that are needed by participants in nuclear engineering. An introduction to the principles of the nuclear reactor, to include a fair understanding of the characteristics of the neutron flux distribution, of the criticality conditions for various types of reactors, and of the dynamics of the reactor is required. Fuel element design, the heat transfer loops, materials of construction, shielding — all call for study for this common background.

How can these be taught? One way would be to introduce them in an introductory course. Many schools are doing just this. I believe that many of these items ought also to be incorporated more intimately in the "standard" courses of mathematics, physics, mechanics, and in engineering courses. The laws of radioactive decay can be introduced nicely in mathematics. Commissioner Willard F. Libby has suggested that a radioactive tracer experiment be given in chemistry courses.

What of the more advanced training for work on nuclear systems; what should the training include, and who should do the teaching? There can be, and are, many views on this. There are those who would look on such advanced training as of the type that should be gotten from industry or from national laboratories. Others see it to be the function of a nuclear engineering department, where the staff of such a department would presumably possess the same kinds of special skills that are called for by the variety of nuclear engineering problems.

I am inclined to consider both views to be somewhat short of the best, because the job is more basic and extensive than industry or the national laboratories or departments of nuclear engineering can handle. In the case of the nuclear engineering department, presumably the chemical processes and processing plants would be taught by a chemical engineering member of this department. We will assume, perhaps over-optimistically, that he brings to his nuclear lectures the most advanced outlook on chemical plants which can be drawn from non-nuclear industries.

But since he is a member of this nuclear engineering department, and not of the chemical engineering department, his participation in nuclear work will fail to reflect benefits of the nuclear work to the chemical engineering curriculum. The same holds true for every other department; the benefits of advancing nuclear technology cannot reflect to the various curricula without direct participation of each department in the nuclear teaching. This represents a major loss.

The Nuclear Program at R.P.I.

Within the past few years colleges have become fairly active in developing courses of one type or another related to nuclear engineering. Quite a few offer introductory courses to nuclear reactor theory, while others have added enough courses to warrant major emphasis in the nuclear field.

Actually, relatively few schools have been privileged to pursue the directions of their preferred choice; most of us

have had to accept compromises imposed by shortages in men and money. Some schools have had additional difficulty in getting agreement and concerted action among departments.

At R.P.I. we have had our share of difficulties with respect to money for facilities and for staff. We have had one very major factor in our favor, however, in that the science and engineering divisions decided early that the nuclear program should be sponsored not by a single department or division, but by the whole Institute. A pattern of courses was recommended after joint study; thereafter, six departments proceeded to develop and to offer one or more courses each, addressed to the special problems of nuclear systems.

The physics department gave an introductory course in reactor theory, which is also a prerequisite to most other courses. Chemistry offered three in nuclear chemistry, in radiochemistry, and in selected topics of nuclear chemistry. Chemical engineering gave one on the nuclear reactor and its processing plants, and is preparing to offer an advanced course in the economics of these systems. Mechanical engineering presented heat transfer in nuclear plants, and will follow this with a more advanced course. Metallurgical engineering greatly modified its nonferrous alloys course to include metals of nuclear interest, and has listed advanced metallurgy for nuclear reactors. Two additional departments are planning to offer courses for the coming year.

The management engineering department gave a rather interesting course on the unusual management problems that attend nuclear operations. These include problems in contracting, liability, insurance, materials, controls, and economics of these plants. Four engineering and science departments cooperated to provide the technical background for this course, because of the unusual combination of technical and management problems that characterize these operations.

Qualified upperclassmen and graduate students from any department are permitted to take one or more of these courses as electives. Although a student can easily obtain at least minor concentration in this area, no degree designations are offered.

We have just completed a successful year with this program in the course of which about twelve members of the faculty were helped to develop and teach these courses to over 160 enrollees. The faculty also participated in giving non-credit survey courses to a selected group of 20 practicing engineers at the Knolls Atomic Power Laboratory, and is planning further offerings this summer.

We have gained much from this year. The program to be given next year will be greatly strengthened with respect to trained faculty and research and teaching facilities.

Advantages of Joint Approach

The aspects of our pattern which we particularly favor are:

a) The full strength of the whole Institute can contribute to the development of atomic science and technology. Even our research programs in the nuclear field are often proposed on the basis of joint effort between two or more departments.

b) The benefits of this participation are reflected directly and immediately to every participating department.

We are well aware that the program pursued is tentative in several respects.

(continued on p. 333)

WHAT IS INDUSTRY'S RESPONSIBILITY IN THE TRAINING AND DEVELOPMENT OF ENGINEERING TEACHERS?

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Presented at a Conference of the Relations With Industry Division during the 64th Annual Meeting, June, 1956, Ames, Iowa.

My subject is challenging, to say the least. It tempts one to be facetious. It could be dismissed very briefly by saying that industry's responsibility in this case is analogous to that of the farmer, who strives for better grain yields through the planting and cultivation of tested seed or to that of the rancher, who seeks better beef by the introduction of blooded breeding stock. The end result sought in all cases is an improvement both in the quality and quantity of the finished product. Industry is the "user" of the finished product of the engineering teacher, so why shouldn't industry have a responsibility to help in improving the finished product? And how could industry better discharge that responsibility than to participate in the training and development of the men and women who educate the finished product?

Let me amplify my title a little and add the following: ". . . and how Industry is Discharging its Responsibility."

I must confess that I have sent out no questionnaires, nor have I conducted any polls to determine what other industries have done or plan to do along the line of training engineering teachers. I am sure that such a poll would turn up many interesting and worthwhile programs. But we at the Allison Division of General Motors in Indianapolis have had some first-hand experience along this line. Add to that experience our participation in a program conducted by General Motors Corporation at Detroit each summer, and I believe I may be able to make a few appropriate comments.

I would like to preface my remarks concerning the Allison program by stating briefly the policy behind it. Our top management believes that it is good business to provide temporary employment for college engineering teachers during their summer vacations for the following reasons: 1) Their assignments to work in their respective fields of interest help us to complete many semi-research projects that we are unable to undertake with our own regular engineering staff. Even if the teachers find the project impractical, we are ahead of the game because we would have had to reach the same conclusion with our regular staff after the teachers have returned to their colleges in the fall. 2) Their assignments in

the engineering department of an industry such as ours gives them a first-hand experience with the practical application of their theoretical knowledge. They can become better teachers by having had this practical experience. 3) They give us a valuable contact at their colleges. I hesitate to mention this reason because I believe some industries hire college engineering teachers during the summer primarily to establish campus contacts to help them recruit graduating engineers.

There is a danger in making summer employment too attractive. During the past five summers, three college professors have asked us for permanent employment; and after we found that they were determined to leave the teaching profession, we made them offers, which were accepted. I assure you that we are not pirating from the colleges, but under the circumstances felt that we could do little except to offer opportunities to these three men.

It isn't quite as easy now to interest college engineering teachers in summer industry employment as it was even last year. I might say that our practice is to pay these teachers the same monthly remuneration as paid them by their colleges. We also pay their travel expense from their homes to Indianapolis and back to their homes at the close of the summer program. But now, some of the teachers are only interested in the summer assignment on a retainer basis, and I know of a few cases where the retainers have been considerably in excess of their college salary rates. We, at Allison, have entered no such contracts with college professors to date, although we do have some continuing research contracts with certain institutions.

In addition to the Allison program, which I have covered briefly, we have participated in a program conducted by General Motors Corporation in Detroit. Each year the Corporation extends invitations to a selected group of college engineering teachers to attend a two-week conference. So far this year, twenty-six men have accepted the Corporation's invitation. To give you a rough idea of the program, the first day is in the form of a get-acquainted meeting and also an orientation program outlining the Corporation structure and reviewing in brief some of the plans and programs conducted by the Corporation. Then, there are about four days of field assignments to the conferees. These assignments are in the nature of visits to various General Motors Divisions. In 1955, twenty-four men in the program made visits to eighteen Divisions of the Corporation. I don't mean that all twenty-four visited all eighteen Divisions. As a matter of fact, not more than two men visited any one Division. The conferees then returned to Detroit and on successive days visited the General Motors Proving Grounds at Melford and General Motors Institute at Flint. There followed a complete visit of General Motors new Technical Center on the next day. The following day was given up mostly to the educators themselves for the preparation of reports and presentations, which were given on the last day of the conference.

During their visits to the Corporation's operating Divisions the teachers are the guests of the Divisions. We have always had one or two visit us; and where we formerly prepared a rather elaborate schedule, we now entertain our guests more informally. We wait until they actually arrive and then,

after discussion with the teachers, make up our schedule, which is based on the desires of the teachers themselves. For example, some are interested in manufacturing methods and have little interest in research. In others, the exact opposite is true. In several cases, the teachers have been more interested in our personnel policies and procedures and in our training programs and techniques. In other words, we arrange the schedule to suit the teacher.

All of this has concerned Allison and General Motors. I have noted the recent proposal of General Sarnoff, of the Radio Corporation of America. General Sarnoff suggests releasing with full pay qualified individuals now employed by industry for temporary teaching assignments in the colleges. Although I think this is an excellent suggestion, I doubt, personally, if it could ever be put into effect in sufficiently large scale to be too helpful. In our own case at Allison, for example, we have perhaps seventy-five to one hundred men who are qualified to teach technical subjects at the college level. The difficulty, however, is that with the present extreme shortage of technical people in industry as well as elsewhere, some of our work would be bound to suffer during the period that we released these well-qualified people to assume teaching assignments. Furthermore, I believe that most of them would be reluctant to accept such a temporary assignment, feeling that to do so might eliminate them for consideration in any reorganizational or promotional plans that might take place during their absence.

Another recent news story concerned the gift by the Ford Foundation of about $200,000,000 to subsidize faculty salaries in colleges of arts and science. I have seen no further details regarding this gift, but it looks to me as if this is really something concrete that when applied might make the teaching profession more attractive to the engineering teachers.

In conclusion, I would like to emphasize the fact that we at Allison feel that it is unethical to woo the engineering teachers from the college faculties. It is a very short-sighted action on the part of those industries who do it. After all, pirating a teacher from an engineering college is something like killing the goose that lays the golden egg. Perhaps I should apologize for that analogy — I have the highest respect for teachers and the teaching profession. It might be more tactful to say that such a practice is analogous to grinding hybrid seed corn into meal instead of planting it.

To Summarize

Allison is well satisfied with its present program of employing college engineering teachers during their summer vacations and hopes to increase the number.

We endorse the General Motors two week summer conference program for engineering teachers and will continue to participate in that program by acting as host to those members of the conference who are interested in Allison.

Although we encourage our engineers to accept evening teaching opportunities at the Indianapolis branch of Purdue's Technical Extension School, we regret that we cannot, at the present time, loan qualified men to the colleges for on-campus teaching assignments.

AN IDEALISTIC CURRICULUM IN PETROLEUM PRODUCTION ENGINEERING

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and

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This paper was presented at a conference of the Mineral Engineering Division during the Annual Meeting at Ames.

The first decision to be made in building a curriculum is to decide what are to be the characteristics of the end product — the graduate. It is essential to know also where the program is to begin; that is, what educational background should be required of the student entering the program.

A graduate with the bachelors degree should have the necessary background and training to enter the engineering profession as an engineer-in-training. He should have a working knowledge of the basic sciences and mathematics which support his profession. He should be able to fashion the knowledge so that under supervision, and later as a supervisor, the knowledge will be put to beneficial use. For those whose qualifications lead to research and management, a program of specialization should be made available through post-graduate work on the masters and doctorate and even post-doctoral level.

It must be remembered that in offering an engineering education program the principal objective is to prepare men for all levels of service, not only the top level research and development positions.

High School Preparation

Time is a factor in the educational program. If an undegraduate engineering program of four or five years must be fitted into the total educational program, the raw material (students) must meet certain minimum requirements, and the program must necessarily be limited to the essential fundamental work. Remember that an engineering curriculum offers the beginning phase of an educational program which leads to a highly specialized area of human endeavor. Consequently, it is necessary to give secondary consideration to the humanities — social studies phase of the curricula and encourage the student to develop this part of his education as an extra-curricular activity or through post-graduate study.

It is our opinion that the person who wishes to follow the engineering profession should start his educational program not later than the ninth grade of public school work. A student entering the engineering college should have had four years of English, covering written and oral presentations as well as thorough grounding in grammar and reading. He should be expected to have had some contact with American and English literature. An American student, entering an American university, has completed 12 years of study in the English language. It should not be too much to expect that he be proficient in the use of his native language. A comprehensive examination covering an applicant's knowledge in this area, in addition to certification by high school authorities, would be desirable as a prerequisite for admission.

In the field of mathematics, students entering an engineering curriculum should be required to have satisfactorily completed the algebra that is usually required in a college algebra course, and in addition, completed plane and solid geometry and plane trigonometry. Evidence of competency in this field would be presented by a high school transcript and a comprehensive examination. Furthermore, a student should also present evidence of having completed one year of physics, and be required to take a validating examination covering this material. This course would parallel the beginning courses now offered in college and would lead to a revision of the first course in college physics.

A relatively small percentage of colleges offering approved curricula in engineering require the background in mathematics suggested above. If the majority of colleges would make such a requirement, then more effort would be made to provide high school graduates with a sound background to enter an engineering education program. If the high schools would not provide the training, then a one year program in pre-engineering could provide the background needed.

If the suggestions presented should be adopted, eleven credit hours presently required in many engineering programs could be eliminated. The physics requirement for admission would provide for the addition of subject matter to the present physics course. This would make it possible to add other essential courses or free electives without increasing the current semester hour loads, in Tulsa's case 143 hours excluding physical education or military science and orientation.

Duties of Petroleum Production Engineer

Perhaps before discussing some of the details of a curriculum in petroleum production engineering it would be better to discuss briefly the duties of this type of engineer. According to the U.S. Department of Labor Critical Occupations List these are:

1. Performs engineering work concerned with drilling of wells and production of oil or gas.
2. Studies geological surveys, earth samples, and other data.
3. Advises on type of derrick and drilling equipment to be used for drilling new, or reworking old wells.
4. Supervises drilling operations and offers technical advice to achieve economical and satisfactory progress.
5. Directs testing of bore holes to determine pressure, temperature, direction of drilling, strata encountered, and other features.
6. Recommends and supervises use of drilling mud and casing cement.
7. Directs gun perforating, squeeze cementing, and other special techniques and tools to solve drilling problems.

8. Devises methods for bringing wells into production and controlling flow of oil or gas and for re-establishing flow by artificial means after natural flow has ceased.
9. Recommends procedures for treating oil to remove sediment and water.
10. Supervises maintenance and cleaning of producing wells.
11. Determines gas-oil ratios of producing wells and designates allowable flow of oil or gas to meet proration regulations.
12. Compiles logs for each well, production records on flowing wells, and other data.
13. Conducts special studies on problems such as salt water encroachment and operating equipment.
14. May conduct geological and geophysical surveys.

Curricula

It can readily be seen from the duties of a petroleum production engineer that a young man who wishes to become competent in this field must receive a broad training in mathematics and the basic sciences (physics, geology, chemistry), the engineering sciences (statics, dynamics, strength of materials, fluid mechanics, and thermodynamics) and a sufficient amount of work utilizing these courses in petroleum engineering fundamentals and applications. Of course, the fact must not be overlooked that a student's ability to express himself orally and in writing is also very important. Consequently, work in technical report writing and speech is necessary. Along with his highly scientific and diversified training he should be given some course work in the humanities and social studies. Just how much of this should be required is a highly controversial matter. We feel that a minimum of ten per cent of the curriculum should be required in the humanities and social studies with preferably a greater percentage allotted.

Table I compares an idealistic curriculum in petroleum production engineering with the present curriculum at the University of Tulsa.

It is easy to see that the idealistic differs from the present Tulsa curriculum primarily in mathematics, chemistry, geology, and English. The idealistic would require that a student have the equivalent of seven hours of algebra, trigonometry, plane and solid geometry, two hours of general chemistry, three hours of physics, and six hours of English composition before beginning his freshman university work. As pointed out above, this approach makes possible continuation of the present credit hour load in the over-all curriculum and provides for the addition of other courses which are considered essential to the basic university training of a petroleum production engineer. Some of these are: chemistry of hydrocarbons, colloidal chemistry, solid state physics, mineralogy and rock study, sedimentation, research, and electives in the humanities and social studies.

Table II shows a summary of the two curriculums compared to that recommended by the American Society for Engineering Education. It should be noticed that the comparisons are good in the case of mathematics, fair in the case of engineering sciences, engineering and technology, humanities and social studies, and weak in the case of basic sciences and electives. The reason for this is that in addition to the basic sciences required by other engineering curricula, a petroleum production engineer requires geology. Further, his training in chemistry must be more thorough than required in most other

Table I

A Comparison of an Idealistic with the Present Tulsa Curriculum in Petroleum Production Engineering

Subject:	*Curriculum Hours*	
	IDEALISTIC	TULSA
Mathematics		
Algebra	High School	3
Trigonometry	High School	2
Plane & solid analytic geometry	3	5
Calculus	6	6
Differential equations	3	3
Advanced mathematics for engineers	3	0
	15	19
Petroleum production engineering		
Development	4	4
Production	4	4
Natural gas	4	4
Reservoir	3	3
Subsurface	3	3
Oil & gas separation, transmission, etc.	3	3
Research	2	0
	23	21
Geology		
General & historical	5	8
Mineralogy & rock study	3	0
Structural & petroleum	5	7
Petrology & sedimentation	3	0
	16	15
Engineering sciences		
Mechanics of solids		
Statics	3	3
Dynamics	3	3
Strength of materials	3	3
Fluid mechanics	4	4
Thermodynamics	5	5
Electrical theory	4	4
	22	22
Technology		
Engineering drawing	4	4

Subject:	*Curriculum Hours*	
	IDEALISTIC	TULSA
Physics		
Engineering (with revisions to include modern development)	10	10
Chemistry		
General inorganic	4	5
Qualitative	4	5
Quanitative	4	4
Physical	4	4
Chemistry of hydrocarbons	3	0
Colloidal chemistry	4	0
	23	18
Humanities & social studies		
English literature	3	2-3
Religion	3	3
American history	3	3
American national government	3	3
Economics	3	3
Economics, engineering application	3	3
Electives, restricted	6	0
	24	17-18
English		
Composition	High School	6
Technical reports & public speaking	3	3
	3	9
Other		
Orientation	1	1
Accounting	0	3
Physical education or military science	4	4
Electives	3	5
	8	13
Total hours required for graduation	148	148-149

Table II

Summary of Idealistic and Tulsa Curriculums

	Idealistic[1]		Tulsa[1]		Recommended by ASEE[2, 3]	
	Hrs.	Percent of Total	Hrs.	Percent of Total	Hrs.	Percent of Total
Mathematics	15	10.5	19	13.3	18	12.5
Basic sciences	49	34.2	43	30.0	18	12.5
Engineering sciences	22	15.4	22	15.4	35	25.0
Petroleum production engineer	21	14.7	21	14.7	35	25.0
Technology[4]	9	6.3	16	11.2		
Humanities and social sciences	24	16.8	17	11.9	28	20.0
Electives	3	2.1	5	3.5	14	10.0
Total	143	100.0	143	100.0		105.0

(1) Excluding physical education and orientation.
(2) "Report on Evaluation of Engineering Education," ASEE, Report 1952-1955 p. 22.
(3) Based on a curriculum of 140 hours.
(4) Includes accounting, English composition, and technical report writing and speech.

engineering fields. As compared to the ASEE recommendations, these two facts cause a curriculum in petroleum production engineering to be excessively heavy in the basic sciences and somewhat weak in the engineering sciences, engineering, humanities, social studies, and electives. Elimination of geology and some of the hours allotted to chemistry would make it possible to balance the rest of the curriculum in conformance with the ASEE recommendations. This would, however, weaken the program instead of strengthening it, and as a consequence, is not advisable.

It should also be noticed in Tables I and II that nearly sixty per cent of the idealistic and the present Tulsa curriculums is devoted to mathematics, and basic and engineering sciences. On the other hand, only 15% is devoted to engineering. The approach adopted here is better to prepare the embryo engineer for a highly scientific and constantly changing oil industry. At the

Table III

Summary of Petroleum Engineering Curricula in Several Universities*

Subject	Texas A & M '55-56	U. of Texas '55-56	U. of Kansas '54-55	LSU '54-55	U. of Okla. '56-57	Texas Tech '54-55	Penn State '56-57	U. of Tulsa Present '56-57	U. of Tulsa Idealistic
Chemistry	17	19	19	8	13	14	18	18	23
Geology	15	15	15	23	14	18	17	15	16
Mathematics	15	14	18	15	18	21	16	19	15
English	9	12	10	13	11	9	9	11-12	6
Physics	10	12	10	12	10	8	10	10	10
History and government	3	12	0	6	6	3	0	6	6
Physical education or military science	4	0	0	2	4-8	5	10	4	4
Engineering drawing	4	6	6	2	5	5	2	4	4
Topographic surveying	2	2	3	5	3	3	6	0	0
Thermodynamics and laboratory	6	6	3	8	6	7	6	5	5
Mechanics of materials	3	3	4	6	4	3	0	3	3
Mechanics (static and kinematics)	6	3	5	4	5	6	3	6	6
Fluid mechanics and laboratory	3	3	3	4	3	4	0	4	4
Chemical engineering and refining	0	0	0	0	0	0	4	0	0
Internal combustion engineering and mechanism	0	3	3	0	3	3	0	0	0
Electrical engineering	4	3	3	0	5	8	4	4	4
Economics, business law or accounting	0	0	3	3	0	3	0	9[1]	6[1]
Petroleum production engineering	30	25	20	24	25	21	27	21	23
Electives	14	8	14	9	5	6	12	5	9
Other	3[2]	0	1[3]	0	3[4]	3[5]	1[6]	4[7]	4[7]
Total hours	148	146	140	144	143-147	150	145	148-149	148

*Taken from the school bulletins for the years shown. The writers' wish to point out that where a subject is not offered, it is quite possible that the same material is covered under one or more other topics.
(1) Includes three hours of economics, engineering application.
(2) Engineering problems.
(3) Elements of shop practice.
(4) Industrial education and engineering II.
(5) Orientation and engineering seminar.
(6) Mineral industry lecture.
(7) Religion and orientation.

same time, enough humanities and social studies are included to aid him in becoming a better citizen and to broaden his intellectual outlook.

Table III shows a summary of petroleum engineering curricula in several universities for the years indicated. This table shows a relatively close overall agreement on the content and hours devoted to the various subjects by the universities surveyed.

Because of the marked differences that exist between the petroleum production engineering curriculum and those for the other types of engineering, it is the contention of the writers that representatives of the petroleum production departments of the oil industry should participate in a major way in its evaluation. This can perhaps best be accomplished (and is presently being accomplished to a certain extent) through the Petroleum Branch of the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME). The Petroleum Branch of the AIME has, within the past two years, set up an Education Committee whose functions are to make recommendations regarding educational matters.

AIR FORCE ACADEMY

In October, 1956, construction was begun on the first permanent buildings of the Air Force Academy, ten miles north of Colorado Springs, Colorado. The site of the new Academy is comprised of approximately 17,500 acres at the base of the Rampart Range of the Rocky Mountains. The land is broken by a series of ridges, mesas, and valleys.

The academic area will contain cadet quarters and store, academic structure, library, chapel, social center, and a planetarium. To the east will be the parade and drill fields, overlooked by the administrators' quarters. Additional facilities will include a physical education building, maneuver area, hospital, bachelor and visiting officers quarters, officers mess, golf course, faculty family quarters, community center, athletic fields, and family housing for officers and airmen of the support organization.

The architectural style is contemporary with glass, white marble, and aluminum the principal facade elements. The major structural materials will be reinforced concrete and structural steel.

COMPETITIVE CONDITIONS IN INDUSTRY WHICH ATTRACT THE TEACHER

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Presented at a conference of the Relations With Industry Division, June, 1956, Ames.

The shortage of college graduates, particularly in scientific and engineering fields, has resulted in a somewhat fierce competition for their services among industrial concerns, and has extended to similar competition between industrial groups and the universities for this competent trained personnel. Historically, the universities have had a decided advantage over most industrial organizations in the acquisition of engineers and scientists because of the recognized professional aspect of professorial rank. Unfortunately, there has been some tendency in recent years to fail to recognize fully the importance of the teaching profession at the university level, and certainly at the secondary school level. This has caused a serious loss in the prestige of a teaching position. This feeling has affected the student body to the extent that many brilliant men prefer to take employment at the bachelor degree level rather than continue for advanced degrees, thereby preparing themselves for professorships.

It seems only proper at this point, to recognize fully that many competent people are still remaining on the faculties of our colleges and universities; that much inspirational teaching is being done and much excellent research is being carried on. Even today in Europe and in many places in America, the rank of professor is far more sought than are academic degrees of Doctor of Philosophy, Doctor of Science, or Doctor of Jurisprudence.

In an attempt to analyze competitive conditions in industry which attract the teacher, the foremost and most obvious revolves around "money," rather than "remuneration," "salary," or "pay." It is a known fact that individuals employed in engineering and scientific activities in industry not only start at salaries considerably higher than those who start in the teaching profession, but quite frequently, ultimately receive greater financial reward. A casual check of offers to Ph.D.'s by industry this year reveals a range of $7,000 to $12,000 per year, with the median wage being approximately $8,000 per year.

This is considerably more than was offered by colleges and universities to men of similar educational background. With the expanding production and urgent need for technical research and "know how," promotional opportunities are more frequent in industry. Promotions and remuneration closely parallel each other, and as promotions normally re-

flect greater responsibilities, they usually carry with them a higher price tag.

Many desirable fringe benefits are now available in many industrial concerns which are far more extensive and advantageous than those that are provided for teachers and university research workers. The tendency in industry is for these benefits to continue to expand, and salaries are not only influenced upward by such factors as "cost of living," but more recently by "productivity" and other criteria which tend to raise the over-all wage platform.

Most industrial concerns have merit increase programs by which superior performance on the same job can be recognized by increases in pay, rather than basing the increases in remuneration on the number of degrees or length of service, as is frequently the policy in the teaching profession. Industry's type of program tends to encourage superior performance and to permit a policy of promotion from within. The knowledge of such a policy is one of the greatest incentives for attracting some of the best minds to seek industrial association. In providing promotional opportunities for the best qualified men, industry has recognized the need to develop their latent potentialities.

Policies such as having special courses offered following employment, special lectures by eminent authorities in various specialized fields, the returning for further formal schooling, conferences on numerous related subjects, job rotation to broaden knowledge and enhance promotional opportunities, and many other familiarizing programs, *all* give assurance to the outstanding individual that his possibilities and potentialities will be fully developed. The knowledge of this concerted effort on the part of industry to improve the individual and make him better qualified is a strong incentive, causing greater interest in industrial employment than in the teaching profession.

Another advantage accruing to the individual in industry lies in the *opportunity of accomplishment* brought about by the magnitude of opportunities due to larger operating budgets so readily available for technical service, management staffs, or research. Seldom, if ever, does the director of *research* in an educational institution have at his command a sufficiency of funds to provide facilities and equipment, as well as manpower, to carry out the projects of his dreams; whereas, frequently in industrial activities, no stone is left unturned to provide imaginative and creative workers the means to expedite accomplishment of the task presently at hand.

We would be amiss in our appraisal of this problem if we failed to consider that during the young graduate's formative years, he has placed a greater importance on industrial contribution than on teaching. This is understandable, as more of the things he is desirous of acquiring and most of the activities he dreams of ultimately doing, occur in the industrial world. He has seen wealth and social position reflected by many tangible possessions and most of these are in the hands of the community leaders who have been successful in the industrial world. He has naturally concluded that the accomplishments of an industrial concern seems to be more important in their direct applicability to everyday life, and that an organization concerned with making profits for its stockholders must provide services or commodities for ready use. This seems to provide for a feeling of making a greater con-

tribution to the welfare of humanity, and though the feeling may be somewhat false, it does offer a very satisfying reward to the professional man in industry.

No person in industry can deny that large and extremely important contributions to industrial professional development have been made by members of college faculties as the result of their working in industry during the summer months, their being retained as consultants by industrial concerns, and by research projects at the school financed wholly or partially by industry. The faculty member properly placed on a project will fully earn the money paid him for summer association, and his contribution as a consultant frequently aids professional management to solve problems and reach decisions with accuracy. This is equally true of research projects carried on at the school for industry. While added financial remuneration flows to certain faculty members because of these and similar "extra-curricular" activities, and more proficient teachers frequently result because of them, it cannot be denied that the undergraduate recognizes that this added money, efficiency, and increased prestige is the result of *industrial* association. He frequently concludes that the secondary industrial activity is more important than the primary activity of teaching on a college faculty.

While we have recognized the importance that "money" has played in influencing the decision to join an industrial organization rather than a college faculty, we would be omitting several significant influences if we stopped here. An influence of extreme significance is that of *broader recognition.* By the very nature of *staff* association of many professional men in industry, the technical man is suggesting, advising, recommending, and aiding management in the day by day solution of many problems. While it is recognized that the prerogative of final decision rests with management, by the very nature of this association, more and more professional men are going into top managerial jobs. This opportunity for professional men in industry is a keen incentive for them to seek professional association in industry, as the filling of top management and administrative positions conveys with it not only excellent financial reward, but also the opportunity of supervising large staffs of people. The exercise of control in the field of human relations as well as in the particular science or professional field, offers a very rewarding opportunity for prestige that is not possible except in the industrial world.

While individuals in the teaching profession are generally well recognized, they get their greatest recognition from individuals of like interests in the academic world, whereas a professional man in industry has opportunity for numerous contacts, covering other industries over wide geographic areas.

His company usually encourages him to belong to professional groups, to hold office and actively participate at company expense in order that he can sincerely feel that he has recognition as a professional man and is making a worth-while contribution as a member of a professional group. Industry has recognized that the basis for human relations is the *human dignity of the man;* that men in industry must have a feeling of belonging, a knowledge that they are making a worth-while contribution, and a realization that through their own efforts, they can

build for the future, not only stability of employment, but tangible and intangible advantages for themselves and their families. They can sense a feeling of being an important member of a team, and the accomplishment of this team can mean keen satisfaction to each member of it, their families, and friends. Professional men can have a true feeling of pride of accomplishment which provides a true incentive to do better work, resulting in developing a fierce pride of association or "*esprit de corps.*" Professional men in industry are provided opportunities for feeling *important.* They have status and dignity, and opportunities exist which will permit them to fulfill their aspirations and hopes for themselves and for their families.

By continuously improving communications, industry informs the professional man of what the company is trying to do, which results in an awareness of personal concern for him as an individual and *personal* recognition of the importance of the part that he plays in the over-all achievements of the company.

Do not think that any loss of prestige or growing scarcity of well-qualified teachers is not of real concern to industry as well as top educators, as this is far from true. Many tangible efforts on the part of industrialists have been pitched toward maintaining the fully deserved high professional status of the teacher. Much evidence is available indicating that the necessity for improving the present situation is even better known by educators in all sections of our country, and there is some satisfaction in the knowledge that at most of our schools of higher learning, there is the effort to continuously enhance the importance of college teaching as a most desirable and useful calling. In order to accomplish the desired results, the concerted efforts of the educational administrators and industrial representatives should be in close harmony so that the size and seriousness of the problem be recognized and fully appreciated, not only by those of us who are close to the situation, but also by average citizens who are enjoying the fullest and most complete life of any people in the world as the result of the contributions made by college graduates who have been instructed and guided by the faculties of our schools during their most important years.

America cannot permit anything but a positive ringing "yes" to the question raised by Dr. R. J. Russell, Dean of the Graduate School at Louisiana State University — "Can higher education survive?" In order to do this we must not only increase the financial reward to our teachers, but we must secure greater acceptance of them as a truly important segment of our professional society, giving them the recognition and prestige they so richly deserve.

65th ANNUAL MEETING
CORNELL UNIVERSITY
ITHACA, NEW YORK
JUNE 17-21, 1957 — JUNE 17-21, 1957

WHY INDUSTRY LIKES THE CO-OP

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An address presented at the joint dinner of the Relations With Industry and Cooperative Education Divisions, June 26, 1956, Ames, Iowa.

As the material for this talk was being considered, my first reaction was "What can I tell professional educators about education?" It seemed apparent that if I could bring you any new or original ideas they must come from the shop period or the post-graduate experience of co-ops in industry. I propose, then, to give you some of the reasons why we in industry like cooperatively trained men, and to point out some of the ways in which the student can further improve himself during his work periods and take advantage of his unique opportunities.

I was talking with "Boss" Kettering about co-op education the other day and in his characteristic way he said, "Co-op education is the education for the future. It doesn't dwell on repeating the learning of the past." Of course, the big advantage of co-op training is in the shop period, so let us examine some of the things which the co-op can learn while he is away from school and in the shop.

Human Relations

I will never forget an experience I had on my second job. The head of the company was an acquaintance of my father's and occasionally was a guest in our home. The department where I worked was on the route between the company garage and his office and each morning he would walk through with his cigar at a jaunty angle, looking neither to the right nor left until he came to my machine, where he would unbend, give me a big smile and say "Good morning, Fred, how are you today?" then resume the straight-ahead stare as he went on to his office — followed by the glares of the other men.

Brother, was that the kiss of death! You can imagine how long I stayed there. But you also can be sure that I resolved to lean over backward to avoid ever doing anything like that. Many of my friends' sons co-op with us from the General Motors Institute and I have a little talk with each one when he starts — I may be "Uncle Fred" to him at home, but at the plant he expects and gets the same nod and greeting as the other boys — no more no less — and it works very well.

At another plant I had the privilege of watching its unionization from the first days of handbills at the door to the hour a strike was called — hearing the men discuss the idea — all of the arguments pro and con -- the meetings — the speeches — all viewed from the inside, as one of them — having their confidence and seeing their reactions and behavior at each step. Where else could such a clear, true understanding of labor be gained?

A co-op learns early to appreciate the other fellow's viewpoint — tries to understand and see the reasons for an opinion different from his own. He finds that agreements are quickly reached when only facts are presented; it is only when personal opinions clash that arguments cannot be settled.

Let me cite an example having to do with some studies and experiments we undertook to arrive at a wedge-type combustion chamber for our 1949 engine. This wedge-shaped chamber is one of a large number which we tested. We continue to test many shapes but remain committed to the wedge because it yields the optimum balance of power, reliability, fuel economy, and smoothness. My example on fact versus opinion has to with smoothness.

Smoothness is, of course, a subjective factor, and our engineers could have spent hours on end in meetings arguing about the smoothness of various shaped combustion chambers on otherwise identical test engines. Agreement was reached easily, however, through photographs of sound spectrograms. The photographs showed factually the sound intensity at every engine speed of each chamber shape considered. On smoothness, there could be no argument because the wedge-shaped, turbulent chamber clearly resulted in the lowest sound intensity.

The co-op quickly learns the lesson that facts are of much greater value in engineering than are opinions. Yet, some things always need to be left to opinion and it is in the opinion area that the student learns tact. He learns tact in dealing with those inclined — in his opinion — to be difficult or stubborn. Tact is necessary both for the loser and the winner. It is akin to sportsmanship in athletics. A losing team exhibits good sportsmanship by gracefully acknowledging defeat without destroying the inner vow to victory in a second meeting. A winning team exhibits good sportsmanship by gracious acceptance of the victory, but leaving the losing team in a mental frame to go out and beat every other team in the league — including those which already have beaten today's winner.

Frequently the co-op takes a permanent job with the firm with which he has worked before, and finds himself accepted by the other employes much more readily than the "college graduate" who comes in cold from the outside. The co-op has been their boy, he talks their language, they have watched him grow and develop. They have at the same time learned respect for his ability — where the other man has to prove himself from scratch in a much less favorable atmosphere.

From the viewpoint of management, the co-op is potential supervisory material and they appreciate the opportunity to "preview" the man on the job. How much better chance he has of being offered a responsible position than one who comes as an unknown from the outside and, far too often, does not appreciate the requirements of the job. Frequently, the standard graduate comes to us with preconceived ideas of the way he thinks he should work, ideas which may be completely out of line with the way we want the job done. The result is that a great deal of time must be spent in orienting him to our practices and methods. Many companies now maintain graduate training courses of up to two years to help the man through this adjustment period. The co-op, of course, does not need this extra time or training in accommodation.

New Methods and Processes

An example of how the shop periods round out and fill in training was well illustrated by one of our co-op students. He had been given an assignment requiring the calculation of a cam contour, and being of the type that preferred to do a job without asking for assistance, he went at it with the conventional math he had learned — and spent two days on it. As so often happens, the first try was not the answer and as he was preparing to do it all over again, one of our most experienced designers stopped by and saw his problem. Sitting down with him for a few moments, he showed him a short graphical method that did the job in less than an hour.

There are two lessons to be learned from this. First, of course, the advantage to the student, but second was to his college. The co-op took the information back to school, showed it to his math professor and it was soon incorporated in the machine design course. Thus, the co-op school can be kept up-to-date on the newest industrial practices through the eyes and ears of its students.

Here perhaps is as good a place as any to put in another plug for this principle. Not only through the students' reports but by actively taking steps to keep abreast of the new developments in commercial practice the school must continuously review, judge, and revise its courses.

The most direct way to accomplish this is to arrange summer employment or inspection trips for the professor or instructor so that he regularly keeps in touch with those in industry who are putting into active practice the subjects which he teaches. Or, alumni may be invited back to help review the courses and help keep them modernized.

I would like to go one step further, and call attention to the singular advantage which teachers of co-operative students have over faculties in conventional engineering programs. The recent "Report on Evaluation of Engineering Education — 1952-1955" appropriately considered the development of a suitable faculty along with its general recommendation for a "scientifically oriented engineering curricula."

This report set as one of the requirements for engineering teachers their "continual contact with the forefront of engineering and scientific progress." There are many ways for the engineering teacher to achieve this objective. He who teaches co-operative students, no doubt can remain well grounded on engineering practice by drawing out in day-to-day contact with students just how they apply the fundamentals taught in the classrooms. Students become fairly good observers of operations in their co-op firm, and can serve as a constant source of information on engineering practice—not only through their reports but through their orally expressed observations.

This information source is unique to those who teach co-ops. I might add that we in industry get quite a lot of information, too, on teaching practices from our co-op students; both sides benefit from this human tie between engineering education and industry.

Another unique advantage enjoyed by the co-op comes from his contacts with his classmates. Not only does he profit by his own shop experience but he also picks up a great deal of valuable information from others, for rarely do two co-ops get together without the subject turning, sooner or later, to their

jobs. And at the inevitable "bull sessions" one example leads to a second — which reminds someone else of another interesting experience and so far into the night. And all this is in addition to his organized co-ordination classes with their formal reports on work periods.

Economics

The co-op brings to his job an appreciation of the basic importance of economics. He has seen how important it is to manufacture a quality product with the minimum cost for material and labor. And he knows that "labor" means not just the worker in the shop but also his supervision, and all of the hundred and one items that go to make up "overhead" or burden. He sees a part designed and re-designed, each time after careful cost-estimating and consultation with manufacturing men to arrive at the one best method of production.

He knows that the company's success depends upon a quality product at a fair price — offering a better value for the dollar than competitors. These things he learns as he works and sees the proof in every operation with which he comes in contact.

Here, again, is an opportunity to add something of value to the curricula. Just a few weeks ago the representatives of a co-op school were inquiring just how we go about this cost-estimating process, so we showed them through the place — engineering, manufacturing, and financial administration. They are preparing a course in cost-estimating which will be given to their engineering students and which, if properly presented, will be most valuable.

Merchandising

The wise co-op will look past the problem of design, past manufacturing, to the ultimate destination of the product — its sale to the user. No matter how clever the design nor how efficient the manufacturer, if the product is not attractive and desired by the public, all the effort is wasted.

They tell a story around Detroit about dog biscuits — but we all know the product they really have in mind —

> A manufacturer of dog biscuits was holding his annual sales meeting and at the conclusion of the President's address he said: "Now I want to ask you salesmen some straight questions and I want some straight answers."
>
> "Is the quality of our product satisfactory?"
>
> And the answer came back "Yes."
>
> "Are our prices competitive?" "Yes."
>
> "Is our service and delivery satisfactory?" "Yes."
>
> "Does our advertising program have the proper appeal?" "Yes."
>
> "Well then, why are we in fourteenth place in sales?"
>
> And out of the deep silence, a voice in the rear spoke up and said "The dogs don't like it."

So, as he progresses in his work, the co-op will see the importance of keeping his eyes on the real end product — a satisfied customer.

Service

If at all possible, the student should get some experience in the Service Department of his company. This important work brings him into direct contact with the users of his product and provides a picture of the results which are being attained by engineering, manufacturing, and all of the other groups that contribute to the quality of the product. Once he has been in service work he will look to it throughout his career as an unequalled source

of information by which to evaluate the product and point the way to needed improvements.

Again, may I call attention to an advantage which educators of co-operative students have over those who teach in conventional four-year programs. Just as we in industry are concerned about the value of our products to our customers, so engineering educators are concerned that their graduates fulfill their professional requirements upon graduation. Co-op colleges and universities do not, of course, have anything called a "Service Department" but they do achieve the same results. There is a close tie between the producer and the user of the engineering graduate because the student has two campuses.

In a way, your service department is better than any in industry because you are able to get periodic reports on just how the co-op firm feels about your product even while you are building it. We in industry try to make the best possible estimate of what customers will value: then we design, manufacture, and distribute the new model. It is as difficult for us to change a feature in a new model which the customers don't like as it would be for you to change your influence on your graduates after they are employed.

Quality Control

Most companies now have in operation some sort of modern quality control system, and the co-op would be well advised to familiarize himself with its details.

Quality has always been important and in today's competitive market it is even more so. Quality control in mass production is a real art and a great deal of thought and effort have gone into its planning in the last few years. One form is the so-called statistical quality control now widely used. The student should know how it functions and it might be worth including in some part of the school curricula.

Personal Development

Co-op training provides an unequalled aid in personal development. In addition to the characteristics mentioned before, let me point out a few more. It helps the student find himself more quickly. Not only does it rapidly separate the men from the boys, but it gives a preview of just what the profession he has chosen will be like — and early enough so that he is able to change without loss of valuable time. He learns the difference between the individualist and the administrative type — and analyzes himself to find which kind of job he should aim for.

Second, it spurs his ambition. I have seen students who started in college merely because their family thought it the correct thing to do become really fired with the possibilities that an engineering education offered after their first few work periods. How much more helpful to have the benefit of that punch during his entire undergraduate period rather than just after graduation.

Last, the co-op is given every opportunity to develop and improve his judgment — which is just about the most valuable commodity we have. It has been pointed out many times that the higher we look in any organization, the greater the importance of sound judgment. The atmosphere in which

the co-op is trained constantly reminds him of this most necessary quality. He sees sound technical training as a basis for a career — no matter which way he develops. Then, as he progresses he sees that he will need to develop the ability to deal with people — get them to want to do good work for him.

After a limited point he must look to his organization for results. In engineering especially, you do not drive men to do a job — they must be proud of their work and sincerely want to do their best if a superior product is to be achieved. Finally, he sees that at the very top level he must have good judgment, planning ability, and broad understanding. Just as the scaffolding and construction supports are removed from the finished structure, he may even forget much of the detail of his early training, retaining only the basic analytical thinking which he applies to all problems.

This is the high purpose of engineering education as it can be achieved in all engineering schools — but the achievement can come easily through the co-operative system of education. This system has been proved through a half century of experience since its founding by the late Dean Herman Schneider at the University of Cincinnati. In this half century, co-operative education has changed in subject matter and curriculum emphasis, but the basic idea of enabling the student to benefit from cyclic shop and campus residence periods has given co-operative education the flexibility needed to keep the learning process up-to-date. Now, as ever, "Co-operative education is the education for the future. It doesn't dwell on repeating the learning of the past." As industry and education move together forward in an age of rapidly expanding technology, this quality of flexibility is a paramount advantage.

Conclusion

To sum up — industry likes co-op training because it gives them a more nearly finished product — a well-rounded, experienced man, ready to step up to his responsibilities, understanding of his fellow workers, appreciative of his employer's objectives, one who always has earned his way because he wanted to and who knows that his personal success will be measured by his contribution to the success of his organization.

DO YOU KNOW . . . .

(continued from p. 291)

understood by business and industry of whatever size and type;

"Therefore, be it resolved that the American Council on Education establish a committee to study the means for creating a closer relationship between education and business and industry and for implementing their study by regular and continuing action as will appear suitable."

W. Leighton Collins
Secretary

MECHANICS DIVISION BULLETIN

Chairman's Message

FRANK J. McCORMICK

Professor of Applied Mechanics
Kansas State College, Manhattan

The opportunity to revive the publication of the Bulletin as a subdivision of the JOURNAL is greatly appreciated by the members of the Mechanics Division. We hope that this temporary arrangement will prove satisfactory to all concerned and enable us to continue publishing on a permanent basis. No issues of the Bulletin have been printed since May, 1955. We are very thankful to the Macmillan Company for helping us during the past few years. The following five papers represent the Mechanics Division and the Bulletin.

If those of you who have filed previous copies of the Bulletin will re-read the letter from the Chairman in the December, 1953 issue, you will find the statement "Basic material in engineering mechanics is taught today in just about the same fashion as it was thirty years ago."

Probably most of us will agree that this is still true, but a few of you have been doing something about it and we hope that some of these ideas can be presented at Cornell next year. Certainly, in view of the Report of the Committee on the Evaluation of Engineering Education, something must be done to increase our efficiency in the teaching of mechanics and related subjects. Any who have tried experimental programs or have had any experience with unorthodox methods of presentation or integration of subject matter which seemed to increase teaching efficiency are asked to write to your chairman regarding these experiments. Perhaps your experiences can be included in our next program.

There are two committees currently busy with the work of the Division. One is concerned with the experimental examination program, and the other with the possibility of a summer school for teachers of graduate work in engineering mechanics. We shall hear more from them in the near future.

Of the 466 members of the Mechanics Division listed in the current Membership Directory, 58 were in attendance at the Luncheon Business Meeting in Ames. Let us try to increase this number when we meet at Cornell next summer.

EXECUTIVE COMMITTEE

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Editor: Arthur W. Davis, 211 Marston Hall, Iowa State College, Ames, Iowa.

PEOPLE AND TECHNICAL PROGRESS

WILLIAM H. CREW

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of the University of California
Los Alamos, New Mexico

After-luncheon talk to the Mechanics Division of ASEE, Iowa State College, June, 1956. Recommended for publication by the Division.

In speaking to you today about "technical progress," I do not intend to astound you with astronomical figures involving BTU's, kilowatt-hours, or even megatons equivalent of TNT. I shall not dwell upon the accomplishments in travel by aircraft — a subject adequately predicted a generation ago by Alfred Tennyson. I shall not even mention the new catchword "automation" — a process, by the way, of which the use of the buggy-whip was an early example. Although I am not an engineer, I enthusiastically join you in justified admiration of these magnificent, modern, technical developments.

What I propose to do is to look with you at the human thinking and attributes which, over the last three centuries, have brought these great technical achievements to fruition. "Why," we may ask, "has all of this man-made progress occurred while the so-called 'King of Beasts' still stalks his prey in the wastes of Africa?"

History points to the gregarious tendency of human beings to assemble into groups for the purpose of making joint efforts. Let us call it teamwork. For teamwork to be effective there must be communication between the individuals. We must have signals. The human being is not alone among animals in employing teamwork and signals in rustling up a day-to-day living. We know about the bees, the ants, and the pack techniques of the wolves.

But man is unique in one aspect of his communication — namely, his ability to articulate, to utilize his broad spectrum of vocal utterance in conveying general ideas and even precise differences of meaning through careful choice of sounds and inflections. The development of man's skill in articulation can be illustrated by a look into three historical periods of great technical progress: a) the birth of science; b) the founding of engineering science; and c) the large-scale establishment of engineering and science.

I will consider first the 17th and 18th centuries. Early in this period the great Italian physicist, Galileo, threw off the fetters of religious dogma and broke with the traditional acceptance of Aristotelian precepts and established the method of acquiring knowledge through controlled experiment. Happily, by this time the printing press had been developed and, even against the dictates of the church, Galileo was able to publish his works through a clandestine arrangement with the Elzivir Press in Holland. Thus, largely

through the written word, his then revolutionary ideas were circulated and established as the basis of modern science. For the next 200 years technical progress was nourished in the classical universities and the scientific academies of Europe.

My next period is the 19th century, wherein applied science and engineering matured. Physics emerged from the ivy-covered walls and began to appear in the market place. The trend toward applying the new knowledge of nature of the physical comforts and the benefits of mankind was evident. Early in this period the American-born citizen of Europe, Benjamin Thompson — better known as Count Rumford — founded the Royal Institution of London for "the promotion of science and the diffusion and extension of useful knowledge to the common purposes of life." Rumford once wrote to his daughter: "My greatest delight arises from the silent contemplation of having succeeded in schemes and labors for the benefit of mankind." All of us here can participate in the enthusiasm of this great pioneer of engineering — I am still referring to Rumford — who continued: "What exquisite pleasures then must it afford, to collect the scattered rays of useful science and direct them, united, to objects of general utility! To throw them in a broad beam on the cold and dreary habitations of the poor!" The era of applied science, or engineering, had dawned. Technical institutes sprang into being. Applied science reached new heights in halls of learning such as the Polytechnic Institute of Denmark, the École Polytechnique of Paris and the Rensselaer Polytechnic Institute in the state of New York.

Finally, at the turn of the present century, a new element in technical progress appeared. This was the research laboratory. The public had become alert to the benefits of engineering achievements and was prepared to purchase further advances through the creation of government and industrial research agencies. The Physikalisch-technische Reichsanstalt was established in Germany, followed shortly by the National Physical Laboratory in London and the National Bureau of Standards in Washington, D. C. Each of these was a government-supported laboratory dedicated to the marriage of science and engineering. And finally from this union have sprung the great industrial research laboratories which today contribute so largely to current technical progress.

So far I have mentioned three periods of history through which the acquisition of technical knowledge has progressed from the cloistered universities through the technical institutes to the industrial research laboratories. I now invite your attention to certain human aspects of this extraordinary accomplishment, which is truly phenomenal when compared with progress or should I say lack of progress among other members of the animal kingdom. I attribute this progress largely to the ability of the human being to be articulate in communicating ideas from one individual to another.

When Galileo died, his revolutionary application of the experimental approach was not lost to mankind, thanks to his ability to express his ideas in words and to the printing press for perpetuating them. Through communication within and between the classical

(continued on p. 340)

CONTINUITY IN ENGLISH TRAINING FOR ENGINEERS

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Presented at the joint meeting of the Mechanics, Civil Engineering, Electrical Engineering, and Mechanical Engineering Divisions of ASEE at Iowa State College, June, 1956. Recommended for publication by the Mechanics Division.

Every source of information available to those who are interested makes it painfully clear that the problem of continuity in the training of engineers to use English effectively in their professional work remains just that — a problem, and an unsolved one at that. Although many of us in college teaching are concerned about the solution to this problem, much of the concern expressed by industry about the quality of the writing done by engineering graduates is not about continuity of training in communications but about the caliber of the basic training that is given students of engineering.

Industry argues, in effect, that there is no need for continuity of training if the initial course is sound and effective. It must be agreed, I believe, that the first step toward the ultimate goal — engineers who can communicate effectively — is a satisfactory basic course. The more successful the course is, the simpler to solve becomes the problem of continuity in follow-up.

Nevertheless, the problem exists and it is my purpose to discuss, briefly, some of the means by which a solution can be sought. To put it in a different way: How can we, as engineering educators, see to it that a student of engineering learns as much as he is able about how to write and speak effectively? Further, how can we insure that after receiving his credit for the formal English requirement he will continue to use good English and, better still, to grow in skill? At the same time, it may be helpful to consider the obstacles that stand in the way of an effective training program. You will, I trust, forgive me if I draw heavily on my own experience and that of the University for which I work.

Composition Essential

Judging from my twenty years of experience in teaching writing to students of engineering, I believe that a year of English composition is essential as basic training — as the foundation that makes continuity possible and meaningful. Some entering freshmen do not need so much training, to be sure, and provision should be made, perhaps through advanced-standing examinations, to excuse them from the conventional course, but my experience in state-supported institutions convinces me that such students are few.

The basic course should be followed by a half-year of work in report writing (or technical writing, as it is often

called). At just what point in the student's program the latter course should be given is a matter of debate — a debate it would scarcely be appropriate for me to carry on here. I will say, however, that in my opinion such a course does the engineering student most good if it is given during his junior (or possibly senior) year — after he has acquired some engineering subject matter and can, therefore, write reports somewhat closer to being real engineering ones than those he would be able to do during his sophomore year.

But at whatever point offered, such a course is necessary because, to put it briefly, only in such a course can the special writing problems of professional importance to the engineer be given the careful attention they deserve. The freshman year is fully occupied with fundamentals applicable to any kind of writing.

We all know, however, that neither a basic course alone nor the basic course together with a follow-up in technical writing is enough. What else can be done to insure or at least encourage competence in communication?

Professional Support

One rather obvious, if perhaps foolishly idealistic, means is for every teacher of engineering students to insist on high-quality writing in his courses. If this could be done in a thorough way and done consistently (persistently, I am tempted to say), it would solve the problem of continuity. But there are serious obstacles to its practical operation as a method. First, there is the fact that many educators outside the field of English do not feel competent to undertake teaching their students to write along with their technical subject matter. Second, there is the fact that teaching loads scarcely allow time for such extra-subject-matter training and assistance.

If the student is to be helped, he must be told something besides the fact that his writing is inefficient. He must be given *positive* instruction that will enable him to improve his work. And this takes time, not to mention patience, knowledge, and skill. It is hardly possible, then, to make every teacher an English teacher. Nevertheless, to the extent that he is able, each teacher should, I believe, take responsibility for insisting on effectiveness in the writing done by students under his instruction. If a teacher is at all sensitive to the qualities of good prose, he can at least call a student's attention to deficiencies and penalize for careless, slipshod writing.

Ways to Continuity

Another means of providing continuity is to give the engineering teacher an assistant qualified to check the quality of student writing. This is a method we tried for several years at the University of Texas, with considerable success. It works in this way: A graduate student in English with adequate background courses in science is chosen to work directly with the engineering department and its staff. After the technical accuracy of the student's report has been evaluated by the engineering teacher, the report is judged as to organization, style, and general effectiveness by the editorial assistant.

If it turns out (and it often does) that the student has trouble with various problems of usage, say agreement of subject and verb, he is called in for a conference with the editorial assistant, who tries to help him solve his problems. Part of the student's grade de-

pends on the quality of the writing in his report, and he is thus motivated to improve his work as the semester proceeds. A study made several years ago shows that the method is effective.[1] The departments that have tried this technique have liked the results.

Still another possibility for solving our problem is the establishment of integrated or correlated courses in writing and in engineering. At the University of Texas we are trying such a plan in 1956-57. Our basic course in writing for engineers (required after a full year of composition) and a heat power course in mechanical engineering will be sectionalized so that the same group of students will take both.

It is hoped that cooperation of the English instructor and a mechanical engineering teacher will permit a dovetailing of effort so that the same writing projects will serve for both courses. This will require close cooperation on the part of both teachers. Both will have to know what the other plans, and the English teacher, at least, will have to spend some time attending the mechanical engineering class.

Clinic Approach

Two other possible on-campus solutions remain: The use of a special service for students who have difficulty with composition, and the use of a communications standards committee which has the power to defer a student's graduation. At Texas we have in the English Department what we call the English Clinic, where two full-time staff members try to diagnose, prescribe, and treat communications ills. A student may visit this clinic on his own or be sent by any teacher who feels help is needed. The Clinic staff then analyzes examples of his work and plans a remedial program. There are no formal classes; students who work with the Clinic do so voluntarily, on an informal basis. We feel it serves a useful purpose.

The College of Engineering and the Department of English also have a Students' Use of English Committee charged with disciplining students whose English has been certified as inadequate by any faculty member of the college. Upon such certification, the student must then satisfy the committee of his competence or his graduation can be and is delayed.

Industry Can Help

A final possibility remains for continuing the training of engineers to write well — industry-sponsored and administered training. Several companies have set up courses to improve the ability of their engineers to write. Occasionally they use some of their own personnel as instructors, and some import qualified professors from the colleges to conduct such courses.

Such programs have, so far as I know, been tried only within the last few years and it is, therefore, too early to evaluate their effect. One thing is sure; they can do no harm and it is encouraging to the college teacher to find industry assuming part of the responsibility for training in this skill which is so important to technical people. Industry's assumption of this responsibility does not, however, in any way relieve us of our responsibility. We need, indeed we must, continue to try to find ways of solving this problem within our own colleges.

[1] John A. Walter and T. L. Watson, "Communication Deficiencies of Senior and Graduate Chemical Engineers," Journal of Chemical Education, vol. 29 (August, 1952), pp. 402-404.

CONTINUITY IN THE PRESENTATION OF MATHEMATICS

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Presented at the joint meeting of the Mechanics, Civil Engineering, Electrical Engineering and Mechanical Engineering Divisions of ASEE at Iowa State College, June, 1956. Recommended for publication by the Mechanics Division.

The engineering student's comprehension of mathematics and his ability to use it derives from a combination of good courses in mathematics and the continuous use of it in his various engineering courses. It is the mathematician's responsibility in engineering education to teach the necessary algebra and trigonometry, analytical geometry, calculus, and differential equations so that (1) the topics are meaningful to the engineering students and not drudgery; (2) the material is fluid and up to date both for mathematics and engineering; and (3) there is a genuine challenge to the superior students to take more undergraduate mathematics than that required.

It is the engineering teacher's responsibility to use the prerequisite mathematics without avoidance or apology, and to see to it that the superior students take more mathematics as a prerequisite for graduate study, or for engineering work in design or research, or for teaching in engineering. It is our joint responsibility to see that our superior students plan for graduate study and not for a four-year program.

Contentment with the "status quo" is the reason why many teachers fail to keep abreast of current developments. It seems much easier to teach precisely the same course year after year and with the same textbook.

Specific Examples

Let me make these rather dogmatic statements emphatic by citing examples from various courses in engineering.

1) In dynamics there should be more consideration given to nonconstant acceleration in linear motion problems. Too many average students use $v^2 = 2ax$ as a "cure-all."

2) In mathematics we too often so rig our problems that we need to solve $x^3 = 64$, for instance, and not $7x^3 = 29$. We begin, then, the psychology of the *simple answer*. Advanced texts in engineering, especially in the basic engineering sciences, make too much use of the 3-4-5 triangle and other such simplifications.

3) In strength of materials some attention should be given to the problem of beams with non-constant loads. The required integration is simple enough by the double-integration method, and the inclusion of such problems will give the students practice in concepts basic to both engineering and mathe-

matics. In the same course the superior students should be challenged to link the moment-area method to its possible use in the solution of problems in dynamics. There is an important difference between the ability to use a beam deflection formula that can be found in handbooks and the understanding of the limitations of such a formula.

4) In electrical engineering the superior students should recognize that an impedance-diagram solution of a series RLC network with a sinusoidal emf is a convenient method for determining a particular solution of the associated differential equation. He could be challenged, then, by being asked to solve a simple weight-spring-dashpot problem by a similar method.

Also, the mathematics teacher should give some background for this concept of a particular solution by a method analogous to the impedance technique in the treatment of second-order linear differential equations with constant coefficients. The superposition concept should be given more emphasis in both differential equations and electrical engineering.

5) In thermodynamics there is opportunity for continued learning in mathematics, especially in understanding the significance of partial derivatives. Moreover, the superior students could be asked to use their background in indeterminate forms to make clear the interrelations of the gas laws.

6) We in mathematics probably should begin the habit formation of requiring units on dimensional results. Indeed it would be an excellent concomitant if we explained, for example, that the argument in *sin ct* is dimensionless so that c and t have reciprocal units. In a related vein, the use of normalized variables could have important uses in engineering courses; this usually presupposes a significant understanding of the derivative relationship $dy/dx = (dy/du)(du/dx)$.

More Topics Needed

For superior students and for some engineering curricula, at least, (as indicated by the Report of Pasadena Conference on Mathematics in Engineering, JOURNAL OF ENGINEERING EDUCATION, 46:7, March, 1956, 585) more mathematics is mandatory: Fourier series, matrix methods, Bessel functions, vector analysis, boundary value problems and partial differential equations, complex variables, transform methods, numerical methods and computer methods, probability and statistics.

These potential graduate students should be encouraged, no, required, to take more mathematics at both the undergraduate and graduate levels. Such topics are now being covered in mathematics, sometimes in separate courses and sometimes in units designed especially for engineering students. On the other hand there are engineering teachers with rich backgrounds in mathematics who teach some of this material as part of advanced undergraduate courses.

To summarize: The teaching and use of mathematics is a joint responsibility between teachers of mathematics and teachers of physics and engineering courses. To obtain *quality* in our students we must teach physics, mathematics, English, and the basic engineering science courses as a total four-year program and not as completely separate entities. Moreover, the superior students who aspire to practice in design, research, or engineering teaching should be encouraged to take more mathematics than the required basic program.

CONTINUITY IN THE ORGANIZATION OF ENGINEERING DATA

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Schenectady, N. Y.

Presented at the joint meeting of the Mechanics, Civil Engineering, Electrical Engineering, and Mechanical Engineering Divisions of ASEE at Iowa State College, June, 1956. Recommended for publication by the Mechanics Division.

The Mechanics Division of ASEE has devoted a portion of its program to ideas or practices which can help the young graduate organize technical data when he leaves college and enters the engineering or scientific field. My comments will be limited to technical information needed for his later professional work, and will not be concerned with paper work which is properly a part of methods and procedures in any particular business.

What should we tell the engineering graduate? In the first place he already knows that the information he will accumulate over his lifetime will probably exceed his memory ability and therefore he will have to store it in written form. Even if he has that rare asset, a photographic mind, it is useless to burden himself with excessive reference data. This then poses a problem of developing an organized plan for finding, keeping, and using facts needed in his professional work. I have observed an air conditioning expert who carried a small pocket notebook which apparently provided all the basic data he needed for carrying on his own particular application job.

On the other hand, I have known individuals who had immediately available factual information on a vast field of technical endeavor, applying it unerringly from their carefully indexed files which were kept current by well planned methods for fitting newly generated information into the system. A third and distinct type of individual is one so well prepared in fundamental understanding of mathematics and engineering science that he attacks all problems from these fundamentals.

Methods of Attack

Sources of Information. Organizing records may involve collecting information from any one of several basic sources. In a development kind of operation, what you do and learn yourself may have first priority. At the same time, most of us have to keep informed on what associates in our own and related fields are doing and what knowledge pertinent to our work is being generated. Beyond our own group we have the obligation to keep up with information being produced by others here and abroad. (Parenthetically it should be noted that engineers in other

countries are often better informed on our own broader technical knowledge than are many of our own engineers.)

Effect of Type of Organization. In a small company, the engineer has access to only two basic sources of information, that which he or his immediate associates generate, and all of that produced outside. In a large company, there are many sources of technical information which require coordination. Unless exchange channels are open, there is always the possibility of developments proceeding in different areas for different purposes, but involving the same principles.

In a large company, engineers are continuously alert to outside progress and to work in competitors' organizations. Information is gathered through the medium of technical society meetings, technical literature, and the competitive market. If the individual is associated with a college program, his problem differs in that his work is not usually identified with a specific salable product, but is concerned with generating new information. He must utilize all external sources of new technical information and organize the results for his best interest.

Information Storage Systems. In some cases the individual may keep his own, using any indexing system which fits his requirements. If wider files are maintained and used by many, then a system clearly understood by all is needed. This applies primarily to the manually filed system. Often the library maintains data files as well as reference works. If machine storage is used, such as punched tape or magnetic drum for example, then the need of a carefully planned system is even more important.

In our research laboratory, the notebook becomes the first source of information. Docket files, internal research reports, published scientific talks or articles, and the library itself become the information channels. In development work, we find again the notebook, a development file on a specific problem, technical reports and data sheets, and of course technical articles, as the main sources of information to be maintained. In design work, reports of new developments or studies become the basis of final changes and are incorporated into standard practice references. In addition, large quantities of information must be made available to purchasing and product channels for manufactured or engineered products.

Carry-Over Techniques. Some of the techniques of organizing data which can be taught in college are specifically applicable in later work job situations. Here are a few:

a) College Laboratory Experiment. A well-organized college laboratory report is little different from the technical data folder written by the development engineer to record his findings on, for example, the application of a new material to a generator-design problem. A day-to-day journal of every creative and experimental process and observation, the laboratory notebook becomes a permanent record with legal implications in both patent and technical literature fields.

b) College Thesis. In preparing the thesis many sources are examined, data are selected, and the findings or recommendations organized. This is directly related to many of the techniques used in reporting or making recommendations in the technical field. Examples from industry are obvious. A consulting engineer develops a plan of action for a new project, based on extensive field observations. The decisions on entering

a new product field are based on careful studies of all known factors. The technical sales presentation associated with a new strip mill in a steel plant may exhibit the same care and background as the thesis.

c) Library. If the graduating student has not learned to make proper use of the library, he has missed one of the important links in the whole field of record-keeping. It should have taught him the importance of classifying by titles, the organization of information segments in appropriate groups, the part proper indexing has in making material readily available later, the building of files so that they can be expanded, and the associated problems of keeping records current and of destroying useless or unrelated data.

d) Mechanized Systems. It would be a mistake to leave our students with the idea that the organization of data would always be associated with the notebook and file drawer. Where large volumes of information must be processed, industry and government are combining the autotypewriter, punched tapes, punched cards, and the various other data storage systems. Time does not permit more than a single example.

At G.E. we have several departments designing complex assemblies involving a great variety of component parts, large numbers of which are identical. The assemblies, however, fulfill a variety of end-product needs. By the use of punched cards, the entire system can be mechanized for record, ordering, and manufacturing purposes. Detailed part cards are combined into assembly cards. Drawing numbers can be prepared for the production departments, item numbers for the factory floor.

This system has many possibilities. Not only does it relieve the engineer, technician, or draftsman of much organizing, checking and follow-up, but it stimulates development for cost reduction and contributes to standardization. Incidentally, it provides an accurate back-check in case trouble develops on a given component part, the shipping destination of which can be immediately determined by automatically sorting and tabulating cards.

Conclusions

From the foregoing account we can see that new techniques are already freeing the engineering staff for creative functions. By-products of the process are important since they also help organize complex data, take much of the clerical burden out of record-keeping, and may ultimately contribute new methods of organizing great masses of technological information.

Certainly the development of orderly procedures for organizing the vast and growing technological information pertinent to an engineer's professional work is important. College faculties have opportunities to inculcate systematic habits through laboratory, thesis, and library efforts. When the lesson is well-learned, the student and graduate will find that he has increased his effectiveness both for college and career.

UNIFORM EXAMINATIONS IN ENGINEERING MECHANICS

SAMUEL B. FOLK

Professor of Engineering Mechanics
The Ohio State University, Columbus

Professor Folk has contributed his interesting comments on the uniform examination for classes in statics which was tried out on an experimental basis in Ohio and Michigan. We would welcome comments from others in this region who have had the opportunity of giving this examination. Recommended for publication by the Mechanics Division.

Through its Executive Committee, the Engineering Mechanics Division has been engaged in experimentation with a uniform examination for classes in statics. This appears to be a project that should have some chance of succeeding, because the fundamentals of statics are firmly established in a neat well-packaged course for practically all engineering colleges. It seems a worthwhile objective to be able to ascertain whether the different colleges are able to bring their students to a desired level of knowledge and skills and to evaluate the teaching methods which contribute to the most consistent high level results.

Much thought was concentrated on these teaching problems and examination procedures in the Summer Schools for Teachers of Mechanics in 1927.[1] The same problem was attacked with the objectives of (a) developing a minimum achievement test which would indicate whether a student possessed sufficient knowledge of statics to permit him to progress to the next course, and (b) serving as a means of classifying students according to their levels of achievement. Seven large institutions participated in this study,[2] which was skillfully guided by Professor J. O. Draffin of the University of Illinois.

The study was continued through a second cycle of tests, but in the final report,[3] it was admitted that the results were rather disappointing, and that an astonishingly large number of high-grade students were unable to answer correctly a reasonable number of simple questions. There were many contributing factors, some of which seem to be pertinent to the present attempt to "standardize" examinations. My own reasons, which stem from my experience with the uniform examination, are as follows:

1. In writing an examination for several colleges, there are many variables which must be considered. Some universities give as little as two hours for a quarter, and others as much as three or four hours for a semester. The type of problems used, and the techniques developed for solving problems, must vary considerably. The content in some schools includes space frame-

[1] Bull. No. 14 of the Investigation of Engineering Education. SPEE, 1928.

[2] "Progress Report on Achievement Tests," Jasper O. Draffin, JOURNAL xxxiii, No. 3, March, 1942, pp. 228-234.

[3] "Achievement Tests in Mechanics," by Jasper O. Draffin, JOURNAL xxxiv, No. 5, Jan., 1944, pp. 422-432.

works, moments of inertia, catenaries, and other topics which others do not cover. At Ohio State we offer statics to third year students after they have completed their calculus and physics. Consequently we expect them to use calculus in solving problems. As you know, some colleges give statics to sophomores and even to freshmen, whose mathematical ability is far below what we expect of our students. These are a few of the reasons why it is impossible to write a "standard" examination to fit all cases.

2. The objectives of a course in statics will also vary with the particular university and department. We are trying to give our students a thorough treatment of the fundamental principles and by means of examples, expect them to be able to take apart and analyze any new situation they have not seen.

In addition, we believe that engineers are expected to find answers for problems in industry, and hence it is also important to be able to carry out the operations with consistent accuracy. While some believe in setting up "type" problems, our philosophy in education is to expect the student to make reasonable assumptions, draw his own free body diagrams, set up his equations, get an answer, and then check to see if his assumptions have been satisfied.

Such a process requires more than a one-idea problem; connected systems are better. Substitution into formulas we discourage. Any technician can be taught to do this. Handbooks we use only for essential data, and not for formulas.

3. Standard examinations will, I believe, discourage experimentation with a course, and encourage "coaching" to pass examinations, or meet artificial standards. Since the war we have changed our teaching methods, and experimented with different ways of trying to get the best results from students, covering the essential material needed in succeeding courses which depend on statics. A standard examination will compel schools to follow a set pattern and cover the kinds of problems which are prevalent on the examinations.

This seems to me to freeze the course at a fixed level — probably too low a level. It would be more desirable to put on the examinations problems which are a little ahead of the level of the class, or which the class did not have time to cover, in order to place the blame on the administration for squeezing mechanics down to a minimum time and content. In other words, we need to encourage better work and more time allotment to keep up with the advancing knowledge of engineering. Mechanics is now being curtailed as much as possible in order to get more time for advanced courses in the major departments in the four year engineering schools.

4. Perhaps I am prejudiced, but I have seldom seen any true and false questions that I felt gave any indication of the ability of the student. Many can memorize definitions, but cannot produce solutions to problems. Often a student has a clear understanding of the fundamentals in a problem and can write the equations, but would be handicapped by trying to answer true and false questions about it. We were quite dissatisfied with those on the examination, and we found the grades received did not separate our students.

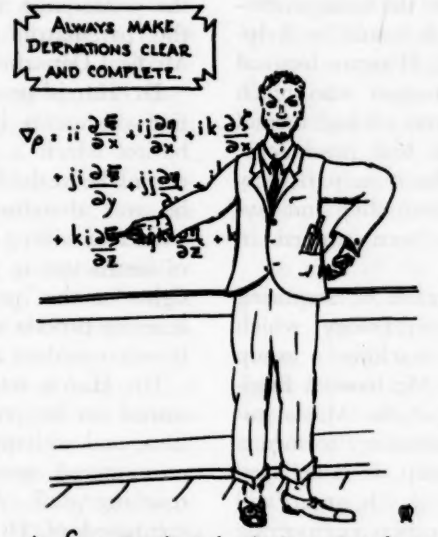
5. On the standard examination there were no problems which required calculus for a solution. We always include at least one. There were no good truss problems, and only one frame

problem, in which, incidentally, it was not clearly stated just what was required. The space problem was symmetrical and the forces concurrent.

There were four problems requiring text book formulas in finding moments of inertia. These, I contend, do not make up a good comprehensive examination in statics. We do not use texts in examinations in statics, because we believe that the fundamental principles can be absorbed and used without reference to formulas in books. In advanced courses where formulas are necessary, we do use books, but there is a major difference between these advanced and graduate courses and elementary statics and dynamics.

6. The level of attainment expected from the students does not seem to be as high on the examination as that discussed in 1927 at the Wisconsin Summer Session on Mechanics. Perhaps it might be possible to experiment with a small group of colleges where the course content, examination routine, time allotted, and the use of books is practically identical. There are too many variables to include others.

PROFESSOR Z. FREEBODY SNAFU


ALWAYS MAKE DERIVATIONS CLEAR AND COMPLETE.
Now, from the physical situation which I am sure you can recognize from this expression, we shall define a new term, Poisson's Ratio —

VIEWS AND NEWS CONTRIBUTED BY

The Young Engineering Teachers

T. A. Boyle, Chairman
Whitmore Lake, Michigan

Robert D. La Rue,
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Colorado A&M College

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University of Notre Dame

TEACHING AND PSYCHODYNAMICS

THOMAS P. GOODMAN

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Massachusetts Institute of Technology, Cambridge
(c/o American Express, Brienner Strasse 4, Munich, Germany)

As engineering educators, we are all committed to the belief that the achievement of practical results in any field is greatly aided by organized training in the basic sciences underlying that field. Yet in our own preparation as teachers, we have had little, if any, opportunity to acquire the basic psychological training which would be helpful to us in teaching. It seems ironical that while our colleagues who teach high school have nearly all had formal training in education and psychology, in the colleges, for the most part, only the members of the counseling and psychiatric staffs have been trained in these fields.

As a practical means of acquiring some training in psychology which would be helpful in teaching, a group of instructors in the Mechanical Engineering Department of the Massachusetts Institute of Technology formed a weekly discussion group. It is believed that the experiences of this group will be of interest to other engineering teachers.

The idea of having the discussion group originated at a student-faculty conference which the writer attended. At the conference, discussion of the usual topics evoked the usual comments from both students and faculty members, and on many topics discussed, the only new light was shed by Dr. Herbert I. Harris, who attended the conference as a representative of the psychiatric staff of the M.I.T. Medical Department.

Dr. Harris' penetrating and provocative comments illustrated the contribution which a psychiatric viewpoint can make in the field of education, and he was therefore asked whether he would be willing to work with a group of instructors to share some of his insights on the "psychodynamics" of the learning process and of the relationship between student and teacher.

Dr. Harris was then, and has continued to be, enthusiastic about the idea, and widespread interest has been encountered among members of the teaching staff. Accordingly, a group composed of Dr. Harris and ten instructors and assistant professors in the Mechanical Engineering Department got started the next semester, and about

half of the original group continued for the following four semesters. Subsequently, three similar groups were formed by instructors in other departments at M.I.T., and a second group was started in the Mechanical Engineering Department.

Range of Topics

The group's discussions have covered a wide range of topics related to the psychodynamics of teaching. The discussions included the relative advantages of various teaching methods, ways of using student motivations to arouse interest, and ways of helping students in overcoming difficulties — as well as the instructor's own motivations and problems. Usually the discussion started out on a specific topic brought up by a member of the group, and then led to a more basic consideration of underlying motivations. The "case method" was found to be effective, inasmuch as all the participants were actively teaching. Dr. Harris added his comments to those of the other members of the group, and often pointed out psychological factors which the others had missed.

The group found discussion far superior to textbook reading as a means of learning about the psychodynamics of teaching, for in a group discussion any statement made can be challenged, and the motivations of the person making the statement can also be analyzed. The discussion group thus becomes, in itself, a worth while experiment in psychodynamics.

The members of the group are unanimous in feeling that the meetings were a valuable experience. They report that the sessions have increased their own understanding of the relation between students' motivations and their progress in learning. The discussions have also led to an increased understanding of the instructor's role in helping students to develop towards maturity, and of the challenge inherent in a teaching career. Also, the group exchanges have given the participants an appreciation of the function of the counseling and psychiatric staffs who deal with serious problems of student adjustment, and of the part which the instructing staff can play by spotting difficulties early.

Effective Approach

For his part, Dr. Harris has stated repeatedly he feels these discussion groups for instructors are his most important activity on the psychiatric staff, since he can ultimately reach many more students by working with instructors than by working with students directly.

A committee of students, organized by the local chapter of Tau Beta Pi to study teaching improvement, heard about the discussion groups and expressed great interest in their activities. One member of the committee said he wished that many more of his instructors could be given an opportunity to participate.

In view of the current expansion of psychiatric and counseling services in many universities, there should be many schools where qualified men with backgrounds in psychiatry or counseling are available to lead discussion groups of instructors. On the basis of experience at M.I.T., it appears that such groups, meeting for an hour a week, can make a significant contribution to preparation of college teachers.

CREATIVITY AND ENGINEERING EDUCATION

H. L. SHULMAN

Professor of Chemical Engineering
Clarkson College of Technology
Potsdam, N. Y.

Honorable Mention, YET Paper Contest, 1955-1956

In recent years there has been much discussion of the roles the colleges and industry should play in the development of trained engineers. In general, the conclusion has been that the colleges should provide broad training in engineering fundamentals, mathematics, and science, as well as a background in the liberal arts. Instruction in the "art of engineering" is to be left for on-the-job industry training.

This informal arrangement ignores the development of creativity, a trait of ever increasing importance in times of mounting expenditures for research and development, accompanied by shortages of engineers. The close relationship between creativity and industrial progress makes an examination of engineering education desirable in order to determine whether more attention should be given to the development of creative talent in college.

Studies indicate that creative potential is normally distributed among the population. This distribution seems to be independent of sex, age, intelligence, and level of education. Creative accomplishment, however, has been found to be more directly related to the output of mental effort than the possession of this inborn, but often unexercised, potential. The fact that there has been so much progress in science and technology in recent years, in spite of the employment of only a small fraction of the available creative talent of individuals, poses the interesting possibility of attaining undreamed-of achievement levels if a larger fraction of this talent can be tapped.

The obstacles to greater utilization of inborn talent are lack of motivation and a variety of mental blocks which result from the environment in which an individual is raised and schooled. The lack of motivation, as evidenced by what seems to be the absence of the desire to succeed, is a problem peculiar to each individual so afflicted, and one which is almost beyond the control of the engineering instructor who must devote his time to many students in the course of his normal duties. Mental blocks, however, can be overcome even by group effort, if they are recognized and definite steps are taken to provide a creative working atmosphere either in school, at home, or on the job.

Advice Offered

A number of books and many articles in the popular journals have been written offering advice to individuals on how to develop and use their creative potential, suggesting creative exercises

and activities as a means of stimulating the use of the imagination. Some of these suggestions call for creative participation in hobbies such as composing rather than listening to music, original painting rather than copying or collecting, writing of prose and poetry, and handicrafts based on original designs. Development of a questioning attitude is recommended so that an open mind can be maintained in order to find all the possible solutions for a problem before judgment is applied to select the best possibility. Although these methods can be of value in stimulating the utilization of creative talent, to be successful they require the rare type of perserving individual, who can obtain his own education from textbooks.

Several colleges have also recognized the value of attempting to stimulate the full use of the imagination, and as a result various courses have been offered with this object in mind. There have been creative courses in machine design, attempts to use mixed groups of faculty and students to attack broad questions, and classes in creative problem solving for which nontechnical problems are used to develop a free flow of ideas. These courses suffer from a common fault — the attempt to develop, in a single course, an attitude which is being discouraged at the same time in just about every other course of the curriculum.

In the same way, realizing that progress depends on creative accomplishments, many large corporations have instituted creative training programs and have adopted creative conference techniques, popularly called *brainstorming* sessions, to develop solutions for suitable problems. Briefly, these techniques attempt to separate the *ideation* stages of problem solving from the *judicial* stages of evaluation. A problem is introduced to a group for possible solutions. The group is encouraged to suggest all sorts of ideas, including ridiculous ones. Evaluation or any sort of critical comment is forbidden at this stage, but combination and improvement of ideas are welcomed. By means of this group effort, a long list of possible solutions is collected, which then are screened for the *best* answer.

These group techniques can be very effective, but they are not suitable for all types of problems. The problems requiring creative work on the part of individuals are still neglected. In addition, it should be recognized that these techniques are designed primarily to overcome the extremely critical attitude developed in the schools, an attitude which hampers the full use of the imagination required for creative work.

To examine this thesis in detail as it applies to engineering education, it is necessary to compare methods used for solving actual problems in industry with those used in training engineering students. An engineer on the job is usually assigned a problem in rather vague terms. The problem may be stated briefly in a written communication, or may be assigned orally. If the engineer uses a logical method of attack, he may work somewhat as follows.

First, he would try to define the problem clearly in his own mind. Then, he would try to gather all the information, either from the literature or from other people, which may be of value in obtaining a solution. As the next step he should try to think up and list all the possible solutions to the problem. When he has attacked the problem from every conceivable angle, he can

evaluate all the alternatives and draw a conclusion. Finally, he recommends the best solution, either orally or in writing, and is prepared to defend it, if necessary, when questioned.

In practice some of these steps may be combined, eliminated, or placed in a different order, but in general the engineer is called upon to use considerable judgment and imagination in planning and doing his work to get at the solution. The more creative the engineer is, the more he will use his imagination to think up alternative solutions. If he is to do a good job he must investigate, at least briefly, all the possible approaches, because he must be prepared to show that he has made a thorough study of the problem and that his solution will prove the best one when everything is taken into account. Also he must try to anticipate and be ready to answer his supervisor's questions if a request for additional study of the problem is to be avoided. In such a situation the ability to use one's imagination and analyze problems clearly is more important than knowing how to make a specific type of calculation when all the conditions are fixed.

Education Unrealistic

An engineering student is rarely, if ever, called upon to solve a problem in this fashion. He is assigned small pieces of subject matter to digest at regular intervals. In addition he is asked to solve relatively simple problems which invariably involve calculations designed to illustrate the use of the material he is digesting currently. The problems are clearly defined, with assumptions clearly stated, and all needed data in text or handbook. The student also knows there is only one correct answer to this problem and the sooner he gets to it the better. There is no reason to use imagination.

Problems to be found on examinations are even worse because there is a time limit and the instructor wants a paper he can grade conveniently. This type of work develops an extremely judicial attitude — everything is right or wrong — there is no room for alternatives. As the art of engineering is eliminated from the curriculum, this type of training will become more prevalent because problems can be used to illustrate the application of the fundamentals of engineering.

In addition, such problems do not call for verbal expression or well-worded answers, so there is very little opportunity to practice delivering and defending carefully prepared written or oral presentations. If the answer is right, it does not have to be explained; if it is wrong it cannot be defended.

A graduate with this type of training and attitude often finds it difficult to adjust to the ways of industry. Relatively few complaints are received about engineers who cannot handle specific calculations such as they have been trained to do in college. The complaints are more likely to deal with inability to analyze problems clearly, to use the imagination, and of course, to present their findings orally or in writing. These complaints are to be expected because so little time has been spent on this type of work.

The stifling of the imagination is started in the elementary schools, continued in the high schools, and perfected in our colleges. Too many recent graduates think the answer to every problem should be found in one of their textbooks or a handbook. If the

answer cannot be found, there must be no answer. The thought of trying to use fundamentals to find an answer never enters young engineers' minds.

Perhaps the black picture which has been painted is exaggerated. In the days ahead, however, with continuing shortages of engineers and a premium on creativity, there will be less time to devote to on-the-job training and efforts to overcome the stifling attitudes developed in the schools.

It should be possible to improve this situation considerably by devoting more time to helping students use their imaginations. This should be not only in solving problems, but in analyzing them and presenting well-prepared results in both oral and written form. Admittedly this will have to be done at the expense of some of the currently used types of work, but perhaps routine problems are being overdone and a little pruning will not hurt.

Specific Suggestions

Several specific suggestions can be offered. Attempts should be made to introduce comprehensive problems for which there is not necessarily one correct answer. The student should be required to analyze a vague problem, make his own assumptions, and develop a number of possible solutions, choose the best one, and prepare a justification for it. The extra time that these problems will require might be obtained by placing more responsibility on the student to read and digest the textbooks without too much aid from the instructor. Just one comprehensive problem per course will provide a student with thirty to forty opportunities to use his imagination and practice presenting his results as he will be called upon to do throughout his career.

Laboratory work should be examined, even in the freshman courses, like chemistry and physics. Attempts should be made to introduce simple original problems which call for the use of some imagination in setting up equipment for taking, analyzing, and reporting data. Brief but well written reports should be required. Here again it will be necessary to take time from the standard type of well-organized projects, but what instructor can claim that every project he now requires is essential to student development.

Comprehensive examinations, with problems which cover the contents of several courses or even the work of two or more years, will give the student practice in using his imagination to put together the pieces of his curriculum so that they can be applied in even more realistic situations. The solutions may be graded more on the approach used to analyze and solve the problem than on the numerical answer.

One important benefit should be noted for the introduction of material which can require an unlimited amount of original thinking. There is the possibility of stimulating the superior (and often bored) student to exert himself to the limit of his ability. With the usual teaching methods, aimed at the average student, there is nothing to challenge the superior student. The better training the superior students will receive may alone justify the use of more creative teaching methods.

To conclude, it appears that the present methods of engineering education are not only neglecting the development of creativity, but are developing judicial or negative attitudes which must be overcome if an engineer is to make full use of his imagination. Perhaps creative exercises should be in-

corporated throughout the present courses to develop inquiring minds capable of analyzing, solving, and presenting the solutions to real problems with a minimum of readjustment for the demands of professional practice.

PEOPLE AND TECHNICAL PROGRESS

(continued from p. 322)

universities and scientific academies of Europe, an international team of scientists was effected, where the findings of each member were made known to others. By means of the spoken and written word, this new knowledge was shared by those who could apply it to the "common purposes of life." It was not alone necessary that the medium of language convey the basic ideas of the scientist, but that the manifold variations in the structure of language be such that these ideas could be resolved and converted to engineering applications. The articulation of language was, in the 19th century, sufficient for Marconi to develop wireless telegraphy from the electromagnetic equations of Maxwell and the experiments of Hertz; and for Edison and deForest to wrest the vacuum tube from J. J. Thomson's electron theory.

I need not dwell on the role of human communications in this present era of the industrial research laboratory. On the one hand we have books, periodicals, and brochures to disseminate technical knowledge and accomplishment. On the other, we have regional meetings, professional sessions, and conventions, such as the one we are now attending, for oral exchange of ideas. Our engineering schools are bursting at the seams. As our engineering and scientific concepts become more involved, the finer nuances of articulation must be employed if effective teamwork between millions of technically employed humans is to be maintained.

I leave you the thought that articulation is an element of eternal importance in human communications. This thought is not new to the engineering profession. It is indeed gratifying to note the continued and growing interest among teachers of engineering in the effective use of language in technical exposition. In fact, this interest is clearly evident in the deliberations of the American Society for Engineering Education.

The roar of the "King of Beasts" in his African lair will continue to be loud. But this roar never will be heard "round the world" in the sense in which Emerson described the shot fired at Concord, nor will it ever convey the myriad of precise ideas which human articulation conveys to man.

GRAPHIC SCIENCE

Analysis — Synthesis — Communication

Sponsored by the Division of Engineering Drawing
Editor: J. N. Arnold, Purdue University

ENGINEERING DRAWING DIVISION, MID-WINTER MEETING — HOUSTON, TEXAS; HOST: THE RICE INSTITUTE

Wednesday — January 30

1:00 p.m. Registration, Lobby of Shamrock Hotel

6:30 p.m. Executive Committee Dinner, Rice Faculty Club

Thursday — January 31

8:00 a.m. Registration, Lobby of Shamrock Hotel

10:00 a.m. General Session, Fondren Library, Rice Campus

Presiding: Professor A. P. McDonald

Welcome: Dr. William V. Houston, President, The Rice Institute

Response: Professor I. L. Hill, Ill. Institute of Tech.

Papers: Narrator, Professor Paul Weaver, Texas A & M

1. The Role of Descriptive Geometry as Applied to Oil Exploration. Dr. W. M. Rust, Humble Oil and Refining Company.
2. How Exploration Information Is Used in Drilling an Oil Well and Developing a Field. Mr. J. S. Blanton, Scurlock Oil Co.

12:00 Noon Luncheon, Rice Commons

1:30 p.m. Board bus for Pierce Junction Oil Field to inspect drilling operations and producing well. Guided by Mr. J. S. Blanton.

2:30 p.m. Board bus for Hughes Tool Company

Evening Entertainment

Friday — February 1

10:00 a.m. General Session, Fondren Library

Presiding: Professor W. J. Luzadder

Papers:

1. Implied Shop Run Geometric Tolerances. Prof. S. B. Elrod, Purdue University.
2. A Graphical Method of Determining the Shadows of a Moving Sun. Prof. J. R. Holmes, University of Texas.
3. Some Interesting Facets of the Design and Construction of The Rice Institute Stadium. Prof. J. R. Sims, Rice Institute.

Panel:

I. Wladaver, Moderator — H. W. Vreeland

M. F. Blade — A. Halasz

Friday — February 1 (continued)

12:00 Noon Luncheon and Business Meeting, Rice Commons
Presiding: Professor I. L. Hill

1:30 p.m. General Session, Fondren Library
Presiding: Professor I. L. Hill or his representative
Papers:

1. Preparation Beats Perspiration. Dr. L. D. Haskew, University of Texas.
2. How Can a Drawing Department Best Participate in Research? Prof. Steven A. Coons, M.I.T.
3. The Rendering of Drawings for Textbooks. Prof. C. H. Springer, University of Illinois.

Panel:

E. W. Jacunski, Moderator — R. G. Huzarski
R. H. Hammond — C. P. Buck

6:00 p.m. Banquet, Rice Commons
Presiding: Professor I. L. Hill
Address: South America in Color. Prof. Cary Croneis, Provost of Rice Institute.

Saturday — February 2

Optional trip to Galveston.

FLOE APPOINTED VICE CHANCELLOR

Dr. Carl F. Floe, a member of ASEE since 1953, recently was appointed as an Assistant Chancellor of Massachusetts Institute of Technology. Dr. Floe is Professor of metallurgy and since 1952 has served also as Assistant Provost. He will represent Chancellor Julius A. Stratton on all matters relating to research.

VAN HOUTEN ELECTED TO A-C-E POST

Dr. Robert W. Van Houten, President of Newark College of Engineering, Newark, New Jersey, and a member of the ASEE since 1933, recently was elected second vice-chairman of the American Council on Education. The Council, which includes 1,113 educational organizations, was founded as a center for the coordination of agencies interested in shaping American educational policies and practices. Dr. Van Houten has been a member of the ASEE General Council since 1953.

DRAWING FOR TOMORROW

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Condensation of a talk presented at the Fifth Engineering Drawing Summer School, Ames, Iowa, June 22, 1956. Recommended for publication by the Drawing Division.

Engineering drawing courses of today are the products of a gradual evolution, spanning in modern times a period of about one hundred years. In the nineteenth century, when engineering was a practical art based upon creative imagination, experienced judgment, and the accumulated wisdom of countless centuries, the graphical expression of engineering ideas was also an art. Drawings were executed with patience and care. Every element of the design, however minute, was represented in life-like detail. Some artistic embellishment was considered entirely proper and desirable. The draftsman was an artist. Functional design had not yet become an excuse for drab and uninspired construction.

Another Era

Now we are on the threshold of another era. This time it is atoms and automation — topics that have been with us for a long time, but only recently have become fascinatingly abstruse and hence very popular. Both have been highly praised and roundly condemned, a sure sign of merit. Much has been learned in these advanced fields, and much has become common knowledge to scientists and engineers.

But the road to further gains in these fields is cobbled with differential equations, higher mathematics, nuclear physics, and innumerable advanced topics. Obviously students who choose to travel such a high road must be well prepared for the journey, a proper function of our engineering colleges. But is it the sole function? Should every engineer be trained as a research scientist, highly skilled in mathematics and physical theory?

It is evident today that the curricula of many engineering colleges are being redesigned and especially tailored to produce pure or near pure scientists. If this trend is continued to its full and logical development, only one problem will remain: Where will we get our *engineers*? Where will we find men to perform the thousand and one "ordinary" engineering tasks of design, development, production, and sales? Who will solve the multitude of engineering problems that can't or need not be expressed in the form of differential equations?

The New Problem

Certainly, the engineer of the future must have a sound fundamental knowledge of scientific principles, but after twenty years of engineering practice he will have forgotten — from lack of use — most of the specialized applications that crowded his junior and senior years in college. At the same time he will have acquired a useful stock of

engineering facts and ideas with which he creates new and improved products. He can express his ideas clearly and concisely in any one of three languages — verbal, mathematical, or graphical. He is partial to none of the three because he is keenly aware of the limitations of each.

His memoranda and reports are accurately worded, correctly phrased, unmistakable in meaning. Most of his ideas are concrete rather than abstract; hence he is naturally more fluent in words and sketches than with higher mathematics. When he can't find words to fit the occasion, and the complexity of his latest creation defies mathematical analysis, he resorts to the graphic language. For the graphical approach is as natural and instinctively logical to him today as it was to his prehistoric ancestor recording exploits on cave walls. Man was an artist long before he knew that his fingers totaled ten.

It is obvious that the engineer can, and does, employ graphical methods at every opportunity. Even if he foolishly disdains the use of graphics, he is continually confronted with the graphical representations of others. They appear on blueprints and sketches, in handbooks and textbooks, in technical articles and advertisements, and in home repair kits. For the technically or scientifically trained person, graphics is inescapable; its value and importance are hardly debatable.

Yet in spite of all these values, instruction in drawing for engineers and scientists is being constantly reduced, squeezed by the downward pressure of additional courses at the junior and senior level. More and more advanced and specialized subjects are being forced into the four-year program.

Since time is so precious today, bold and realistic action is imperative. First, we must ruthlessly weed out of our drawing courses every topic — however traditional or interesting it may be — that is not a basic, vital, and important part of graphics instruction. Second, we must use every hour in the most effective way possible. The success of each class period must be judged by the number of ideas inculcated, and not by the number of precisely executed sheets that have been drawn.

Course Content

With respect to course content, let me give you my own quick appraisal of some of the topics that I consider an essential part of a basic course in drawing.

Of first importance is instruction in sketching and the continual use of sketches at every opportunity. The technique can be taught in a few hours at the very beginning of the course. Thereafter, every drawing principle that can be satisfactorily demonstrated with a sketch should be drawn freehand. Straight-edges, scales, and quadrule paper should not be allowed. Sketches can usually be made in half the time required with instruments, and if the lines are reasonably straight, the proportions approximately true, and the method of solution correct, the sketch is entirely satisfactory. The beauty and accuracy of the sketch are not important, but the solution is. The idea of sketching engineering problems should be so thoroughly inculcated that it will carry over into all of his subsequent courses — where we hope that it will be encouraged and accepted by our colleagues.

The ability to *read* a multiview engineering drawing is absolutely essential to success in engineering. The ability

to *make* such a drawing is definitely secondary. We should therefore concentrate our instruction on the first, and minimize the second. Fortunately, it is perfectly feasible to do this because the process of reading a drawing is entirely logical and mental. The instruction can also be reinforced by the use of blackboard sketches, slides, films, demonstration models, clay models, and even actual objects.

The student's response can be evaluated quickly and easily with objective tests, missing line problems, multiple choice views, pictorial sketches, or even by requiring him to select from a group of similar objects the one represented on the drawing. Every drawing teacher is familiar with these teaching methods, and yet they have not been developed and used to their maximum potential. It is certainly true that most people learn to read a road map without ever having drawn one.

Reduce Instrument Work

Accurate drafting with instruments does consume a large part of the available instruction time, and much of this routine effort can and must be eliminated. But should we discontinue entirely the use of T-square and triangles? Of course not. One does not throw away a valuable precision tool simply because its use requires time and skill! Rather we reserve that tool for occasions when it is indispensable, and the time and care devoted to it are more than repaid in results obtained. Most *design* problems can only be studied and perfected by making an accurate scale drawing. Graphical calculations require precision drafting that can be done only with instruments.

How to draw with instruments is a technique that can be learned in a few weeks by the average student. By the middle of the first term his skill will be adequate for almost any drafting project. Beyond this point any further improvement in skill is largely limited by the natural aptitude of the student. Each subsequent drafting problem should therefore be especially designed to instill a maximum of ideas with a minimum of drafting.

Inking, for example, is a skill that requires little formal instruction but a great deal of practice. Since most engineers will never ink a drawing, one period of instruction should be enough to show how it is done, its difficulty, and why someone else should do it.

There is much talk today of simplified drafting, and one could easily get the impression that this is a radically new and startling development. Actually, graphic symbols and drawing methods have been changing for decades, and a great deal of progress has already been made in the direction of simplification. Much more can be done to symbolize in simple form the many standard items that appear on engineering drawings, but simplification can also be carried to the extreme of ambiguity and confusion. To be acceptable, a new symbol must be distinctive, unmistakably unique, and intelligible to every engineer, draftsman, and craftsman in the country. It should, therefore, bear some resemblance to the actual object represented.

The technique of dimensioning is simple, but the proper choice and placement of the dimensions on a working drawing involve consideration of mating parts, functions, and production processes. The introduction of fits and tolerances further complicates the problem. Considering the meager technical knowledge of the average freshman,

drawing departments could wisely pass along most of their dimensioning instruction to advance drawing and design courses.

Descriptive geometry is usually regarded as an essential part of any basic drawing course, but the subject is so extensive that instruction must necessarily be limited to topics of maximum value to an engineer. Certainly sufficient time must be allowed to build a solid foundation of basic principles.

Emphasize Useful Concepts

Problems of point, line and plane should be covered thoroughly, for here analytic geometry methods are cumbersome and tedious. The general characteristics of all surfaces should be studied, but drafting applications will probably have to be confined to simple cones, cylinders, and spheres. The existence of warped surfaces can only be mentioned. Intersection problems must be limited to those of common engineering occurrence. Perhaps development can be left entirely to the sheet-metal worker.

Some of the specialized aspects of descriptive geometry that must be omitted from the basic course can be introduced later in advanced courses as needed. Vector analysis, for example, is a valuable tool in many fields, and the engineering student should be familiar with the relevant graphical methods.

Finally, every basic course in drawing should include the elements of graphical calculation — the determination of numerical values by graphical methods. The constructions would be primarily those of plane geometry applied to engineering situations, and they would range from the graphical equivalents of simple arithmetical operations to the graphical expression of calculus. The emphasis should be on the simplicity, practical utility, and active accuracy of these methods. The student who for twelve years has been exclusively trained and indoctrinated in the mathematical method must be emancipated from the tenth decimal place. Significant figures, engineering accuracy, and reliability of data are totally new concepts to an engineering freshman, and there is no better place to acquire a keen appreciation of them than in a graphics course.

In Summary

The initial drawing courses of tomorrow will emphasize graphical principles and ideas, but these ideas must be presented more thoroughly and in less time than ever before. Today's course content must be distilled in the mind of every drawing teacher, and only the delicious essence of graphics should be served to future students. Hard work — both mental and manual — will still be required, but the deadening drudgery and wasted hours of routine and repetitive copy work must be eliminated for efficiency.

With its rich heritage of over 5,000 years, graphics is probably the oldest of all sciences. It has guided the thinking of philosophers, portrayed the concepts of mathematicians, expressed the ideas of scientists, and delineated the dreams of engineers. It is the handmaiden of the queen of the sciences — mathematics; it is the visualization of science, and the priceless tool of the designer. Drawing for tomorrow may be taught differently, but it will still be as indispensable to scientific and technical progress as it is today.

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THE ROLE OF NUCLEAR COURSES IN ENGINEERING CURRICULA

(continued from p. 300)

For example, we expect to consider soon whether the one course in heat transfer can be modified and substituted altogether for the current nonnuclear heat transfer course. This may also be possible for some of the other courses, the purpose being both to bring the older courses up to date and also to place nuclear activities in proper perspective.

We believe that nuclear engineering, and especially this integrated approach, helps greatly toward promoting the objectives proposed by the ASEE Committee on Evaluation of Engineering Education, particularly with respect to the call for emphasis on basic science and on engineering science.

In summary, the atomic program will grow effectively only if it is supported by all the science and engineering departments and professions. Conversely, the technical advances that accompany nuclear developments can benefit engineering curricula only when departmental and organizational walls are not permitted to develop into artificial barriers. It is suggested that every effort be made in colleges to promote complete integration of nuclear studies within the curricula and electives of the science and engineering departments.

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PANYAJIVA, FUANG, Commander, Royal Thailand Navy, Newark College of Engineering, Newark, New Jersey. G. B. Thom, J. L. Polaner.

PAUL, JUNIOR A., Engineering Drawing, Product Engineering Department, General Motors Institute, Flint, Michigan. E. D. Black. C. A. Brown.

PAULNOCK, RUSSELL S., Instructor in Electrical Engineering, U.S. Air Force Institute of Technology, Dayton, Ohio. C. M. Zieman, J. J. D'azzo.

PEARL, GEORGE C., Director of Public Relations, Columbia University, New York, N.Y. J. I. Mattill, W. T. Cavanaugh.

PEDROTTI, LENO S., Assistant Professor of Physics, U. S. Air Force Institute of Technology, Dayton, Ohio. J. Lubelfeld, G. R. Graetzer.

PETTY, ELMER E., Professor and Head of Engineering Drawing and Descriptive Geometry, Milwaukee School of Engineering, Milwaukee, Wisconsin. F. J. Lofy, J. J. Budy.

POHRTE, THEODORE W., Assistant Professor of Physics, Colorado School of Mines, Golden, Colorado. V. A. Long, P. F. Bartunek.

PROPPS, JENNINGS M., Instructor in Engineering, West Virginia Institute of Technology, Montgomery, West Virginia. G. C. Slaven, L. C. Nelson.

PUDERBAUGH, HOMER L., Assistant Professor of Engineering Drawing, University of Wichita, Wichita, Kansas. E. L. Cook, L. O. Hanson.

REISSE, CHARLES W., Associate Professor of Mechanical Engineering, Drexel Institute of Technology, Philadelphia, Pennsylvania. J. B. Baker, S. H. Raynes, Jr.

RICHEY, EUGENE P., Assistant Professor of Civil Engineering, University of Washington, Seattle, Washington. J. Higbee, B. Hartz.

ROBICHAUD, EMILE, Professor of Engineering Drawing, College Militaire Royal de St-Jean, St-Jean, Quebec, Canada, J. M. Russ, G. F. Burdick.

ROSSER, HARLEY I., Staff Assistant Instructor, Chrysler Institute of Engineering, Detroit, Mich. A. C. deWilde, L. Henry.

RYAN, NORMAN W., Associate Professor of Chemical Engineering, University of Utah, Salt Lake City, Utah. E. B. Christiansen, S. S. Kistler.

SCHNEIDER, MORRIS H., Instructor in Mechanical Engineering, University of Nebraska, Lincoln, Nebraska. K. N. Newhouse, J. K. Ludwickson.

SCHNEIDER, ROBERT R., Assistant Professor of Civil Engineering, University of Southern California, Los Angeles, California. R. E. Vivian, P. P. Beroza.

SCHRADER, HENRY, Instructor in Drawing, Mississippi State College, State College, Mississippi. H. P. Neal, C. R. Marion, Jr.

SECOR, KENNETH E., Instructor in Engineering, Chico State College, Chico, California. H. F. Langdon, T. O. Reyhner.

SEITZ, FREDERICK, Professor of Physics, University of Illinois, Urbana, Illinois. W. L. Everitt, W. L. Collins.

SHAFER, RAYMOND E., Professor of Industrial Engineering, West Virginia University, Morgantown, West Virginia. C. A. Arents, H. M. Cather.

SHARLIN, HAROLD I., Instructor in Economics and History, Polytechnic Institute of Brooklyn, Brooklyn, New York. A. R. Gruehr, W. L. McCabe.

SHELTON, GEORGE R., Assistant Professor of Civil Engineering, St. Louis University, St. Louis, Missouri. V. J. Blum, J. McCarthy.

SINGLETON, LAUREN W., Associate Professor of Applied Mechanics, Kansas State College, Manhattan, Kansas. M. E. Raville, R. C. Potter.

SMOOT, RONALD L., Instructor in Mechanical Engineering, University of Illinois, Urbana, Illinois. S. R. Davis, J. C. Miles.

SNELL, ABSALOM W., Head of Agricultural Engineering Department, Clemson Agricultural College, Clemson, South Carolina. G. B. Nutt, J. H. Sams.

SPENCER, JAMES W., Associate Professor of Agricultural Engineering, Cornell University, Ithaca, New York. O. C. French, G. Levine.

STERNER, WILLIAM J., Electronic Instructor, Central Technical Institute, Kansas City, Missouri. N. E. Vilander, J. E. Lovan.

STRAUSS, ELLIOTT B., Director of Engineering, Bucknell University, Lewisburg, Pennsylvania. G. A. Irland, J. B. Miller.

STROUT, GEORGE M., Chairman in Mathematics and Physics, Hudson Valley Technical Institute, Troy, New York. J. J. Fitzgibbons, V. G. Clute.

STUVE, FREDERICK W., Assistant Professor of Aeronautical Engineering, Iowa State College, Ames, Iowa. E. W. Anderson, M. L. Millett, Jr.

STYLES, HUGH J., Head, Department of Drawing, Queen's University, Kingston, Ontario, Canada. A. V. Corlett, W. G. Stinson.

SWENSON, C. ROBERT, Assistant Professor of Mathematics, Georgia Institute of Technology, Atlanta, Georgia. H. K. Fulmer, A. E. Fulton.

THIELEN, EVERETT J., Member of Laboratory Staff, Department of Education and Training, Bell Telephone Laboratories, Inc., New York, New York. S. B. Ingram, S. P. Shackleton.

THORNHILL, ROBERT B., Instructor in Engineering Drawing, Wayne State University, Detroit, Michigan. J. A. Day, R. T. Northrup.

TUCKER, JOHN A., Assistant to the Department Head, Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts. C. E. Tucker, T. S. Gray.

TYSON, HENRY B., Instructor in Mathematics, Milwaukee School of Engineering, Milwaukee, Wisconsin. F. J. Lofy, W. A. Van Zeeland.

VALPEY, ROBERT G., Instructor, Mechanics Department, U. S. Air Force Academy, Denver, Colorado. A. Higdon, G. C. Clementson.

WEBB, G. ARTHUR, Director of Engineering, Mellon Institute, Pittsburgh, Pennsylvania. E. R. Weidlein, W. W. Hodge.

WEBB, HONER E., Assistant Professor of Electrical Engineering, Bucknell University, Lewisburg, Pennsylvania. G. A. Irland, J. B. Miller.

WHEELER, ROBERT J., Instructor in Civil Engineering, State University of Iowa, Iowa City, Iowa. J. W. Howe, D. E. Metzler.

WILLIAMSON, MERRITT A., Dean of the College of Engineering and Architecture, The Pennsylvania State University, University Park, Pennsylvania. E. B. Stavely, L. Perez.

WILLS, JAMES R., Assistant Professor of Electronic Engineering, California State Polytechnic College, San Luis Obispo, California. C. A. Herald, H. K. Wolf.

WOOD, LEONARD E., Assistant Professor of Civil Engineering, Purdue University, Lafayette, Indiana. R. E. Mills, W. H. Goetz.

WOODSON, HERBERT H., Assistant Professor of Electrical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts. G. S. Brown, T. S. Gray.

WOOLF, JACK R., Professor of Mechanical Engineering, Texas A. & M. College, College Station, Texas. C. W. Crawford, W. Rice.

WRIGHT, LESLIE A., General Secretary, The Engineering Institute of Canada, Kingston, Ontario, Canada. H. Rogers, T. Saville.

WU, KING CHING, Assistant Professor of Engineering Mechanics, University of Arkansas, Fayetteville, Arkansas. N. F. Tsang, G. F. Branigan.

YORRA, ALVIN J., Instructor in Mechanical Engineering, Northeastern University, Boston, Massachusetts. A. J. Ferretti, A. R. Foster.

150 New Members
135 Previously Added

285 New Members This Year

NINTH ANNUAL COLLEGE-INDUSTRY CONFERENCE

Los Angeles, California

Improvement of the Engineer — A Dual Responsibility of the Engineering College and of Industry

Wednesday, January 30, 1957

8:30 A.M.	Registration
	Morning Session
9:30	Welcome: R. B. Allen, Chancellor, University of California
9:45	The Engineer — What Should He Be?
	Industry's Viewpoint: J. L. Young, Executive Vice President of Engineering, U. S. Steel
	Engineering School's Viewpoint: Dean D. Smith, Iowa State College
11:00	The Engineer — What He Is
	S. B. Morris, Consultant, Los Angeles Department of Water and Power
11:30	Discussion
12:30 P.M.	Luncheon
2:00	Improvement of the Engineer — Educational Phase
	"What Should and Should Not Be Done by the Engineering School?"
	A. J. Ackerman, Consulting Hydroelectric Engineer, Madison, Wisc.
	Dean G. A. Hawkins, Purdue University
3:15	"What Should and Should Not Be Done by Industry":
	E. A. Walker, President, Pennsylvania State University
	L. A. Hyland, Vice President and General Manager, Hughes Aircraft Corporation
7:00 P.M.	Dinner

Thursday, January 31

9:30 A.M.	Improvement of the Engineer — Professional Development Phase
	"What Should and Should Not Be Done by Industry":
	Dean Hollister, Cornell University, Ithaca, N. Y.
	E. C. Wells, Vice President of Engineering, Boeing Airplane Co.
10:45	"What Should and Should Not Be Done by the Engineering School?"
	Dean C. J. Freund, University of Detroit
	H. W. Gouldthorpe, Manager of Engineering Personnel, General Electric Company

Thursday, January 31 (continued)

12:30 P.M. Luncheon
Improvement of the Engineer — How It Can Be Done
Panel Discussion, Moderator, Dean L. M. K. Boelter, U.C.L.A.
S. Ramo, Executive Vice President, Ramo-Woolridge Corporation
Dean J. D. Ryder, Michigan State University
F. C. Lindvall, Chairman of Engineering, California Institute of Technology

3:15 Discussion

7:00 Dinner
"Improvement of the Engineer — What Will It Cost?"
C. C. Furnas, Assistant Secretary of Defense for Research and Development; Chancellor, University of Buffalo

ASEE REPRINTS AVAILABLE

The following reprints can be obtained from the ASEE, University of Illinois, Urbana, Ill. The prices quoted are for single copies; in lots of 100 or more the price is 12¢ each, except as noted. Please enclose check made out to ASEE with the order.

Final Report on Evaluation of Engineering Education
Single copies (25¢)
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Lots of 100 or more (12¢)

Educational Aids in Engineering ($1.00)
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Code of Ethics of Interviewing Procedures (25¢)

Improvement of Engineering Teaching (20¢)

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General Education in Engineering
(Report of the Humanistic-Social Research Project)
Single copies (25¢)
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Lots of 100 or more (15¢)

MINUTES OF THE EXECUTIVE BOARD MEETING

Detroit, Michigan

October 26, 1956

A dinner meeting of the American Society for Engineering Education was held in a dining room of the Engineering Society of Detroit at 6:00 p.m. on Friday, October 26, 1956. Those present were W. L. Everitt, President; W. T. Alexander, C. A. Brown, F. C. Lindvall, and R. J. Woodrow, Vice Presidents; John Gammell, Treasurer; and W. Leighton Collins, Secretary, and E. C. McClintock, Editor of the JOURNAL.

1. *Report of the Secretary,* W. Leighton Collins.

a. Division and Committee Budgets. A list of the requests for funds was distributed. The total for Divisions was $1,560 and for Committees $771, making a total of $2,331. By previous Executive Board action, all requests for more than $50 must be itemized and submitted for approval by the Secretary.

b. Membership. Individual membership applications are being received at a rapid rate; the number so far is at least twice that at the same date last year.

c. Future Annual Meetings. Invitations have been received from the University of Kentucky, the University of Tennessee, and the University of South Carolina. All have been referred to the Annual Meeting Committee for recommendations.

d. Officers' Travel. Since costs of having some officer of the Society attend each Section Meeting whenever possible, will probably exceed the amount budgeted for officers' travel, it was agreed that the expenses of ECAC and ECRC chairmen and secretaries should be charged to the accounts of those councils.

e. ASME Tax Position. The case, with several others, has been referred to the Washington office of the Bureau of Internal Revenue. It is estimated that two years will probably be required before an official decision can be reached.

2. *Report of the Treasurer,* John Gammell.

a. Annual Audit. Copies had been mailed to each member of the Executive Board and a copy placed in the Financial Records book of the Society. Major items were reviewed. The Executive Board *voted* to accept the audit.

b. Quarterly Statement was distributed for information.

c. Transfer of Funds for the Educational Aids Project. Of the funds originally solicited from many industries, $978.95 remain. The supply of educational aids on hand seems adequate for many years and there is no current enthusiam to extend the work into other areas. Consequently, and in accordance with the recommendation of the Auditor, the Executive Board *voted* to transfer the balance remaining in the Educational Aids Fund to the Reserve for Special Projects. (Before the transfer the reserve amounted to $5,317.95).

d. Additional Savings Accounts. $7,500 has been deposited at 3% interest in the Warren Institute of Savings and in the Charlestown Savings Bank, both of Boston, Massachusetts.

e. Funds for Planning of Projects. It has become evident that adequate planning for special studies requires preliminary expenditures before grants are obtained. It was judged to be good practice for the Society to advance needed funds from the Reserve for Special Projects instead of requiring individuals to spend their own money. Any advances made would be charged to the study and would be returned to the Reserve for Special Projects as soon as the grant was received. The Executive Board *voted* to authorize the President and Secretary to use their discretion in allocating funds up to $2,500 at any one time from the Reserve for Special Projects for studies previously approved by the General Council, provided the allocations are returned whenever possible to the Reserve for Special Projects when the study is independently financed.

3. *Reports of Vice Presidents.*

a. ECAC, W. T. Alexander. The work of the various committees was briefly reviewed. Of particular importance was the meeting of some members of the Military Affairs Committee with representatives of the Navy Department to discuss credit for NROTC. Another meeting will be held in December.

A feasible plan for the YET Summer Institute has been developed; there apparently is some difference of opinion among the YETs about what should be done, and they requested that no program be developed for the summer of 1957. Because of uncertainty, the General Electric Company is altering its summer employment program for young instructors to include two weeks of concentrated study on teaching and teaching techniques.

b. ECRC, R. J. Woodrow. The Executive Committee will meet in November, concurrently with the Association of Land-Grant Schools and Colleges. The work of the various committees was briefly reviewed. President E. A. Walker of The Pennsylvania State University has accepted the invitation to speak at the joint ECAC-ECRC dinner of the 1957 Annual Meeting.

c. Sections and Branches, F. C. Lindvall. The form for annual reports from Sections is about ready for mailing by the Secretary's office. The formation of YET Branches was discouraged because the term "Branch" has a particular significance in the present Society structure; it was stressed, however, that the YETs at any institution may organize and meet separately if they so desire.

d. Divisions and Committees, C. A. Brown. A letter has been sent to all Chairmen regarding the improvement of Annual Meeting programs. Joint meetings, more audience discussion, and avoidance of "read" papers was stressed. A meeting of Council representatives of Divisions (16 of 22 being present) was held to discuss strengthening of Division organization by such means as having a vice chairman, an executive committee, and reports of the Council representatives.

4. *Report of the Editor,* E. C. McClintock. Solving the lateness of JOURNAL issues is complicated, particularly if the September issue is to be devoted to the Annuual Meeting and the publisher continues to insist on a three-month lead time. It is hoped that the immediate lateness can be overcome by

having the December issue printed by supplementary facilities to make possible preparation at an accelerated pace. A long range solution may require other actions in rearranging issues.

An expert advertising consultant has been assisting with consideration of JOURNAL advertising policies. He agreed that the present rates were much too low, especially in view of the color pages run for the first time this fall. It was agreed that the amount of advertising could be greatly increased without impairing the quality of the JOURNAL, especially if present quality and arrangement of advertising contents can be maintained.

The Executive Board *voted* that an increase in advertising rates be studied in terms of a report with a positive recommendation to be submitted by letter to the Board as soon as possible. The Executive Board also *voted* that the Editor explore the desirability of placing the advertising in the hands of an agent and that the results of this investigation be reported to the Executive Board, with recommendations, at its spring meeting.

5. *Request of Funds by Chemical Engineering Division.* The funds collected at the Summer School for Chemical Engineering Teachers held at The Pennsylvania State University in 1955 proved inadequate for the customary publication of a *Transactions* volume. The Division therefore submitted a financing plan. The Executive Board *voted* to advance $800 to the Chemical Engineering Division (from the Reserve for Special Projects) for the publication of *Transactions* for the 1955 Summer School, provided that a like amount be returned to the Society funds now on hand and from money collected from the sale of the volume, and provided that the National Science Foundation grants to the Society an amount of $800 to $1,000 which also is to be used to defray publication costs. C. A. Brown was designated as the member of the Executive Board to participate in further planning and activity on the project.

6. *Summer School, English Division.* Request withdrawn.

7. *Procurement and Training of New Faculty Members.* President Everitt reported that Dean H. L. Hazen had accepted the chairmanship of the committee, and that formation of an advisory group was progressing.

8. *High School Science and Engineering Society.* After discussion of the multiple programs in this area, it was agreed that the matter should be referred to ECPD with the recommendation that all current groups be encouraged to coordinate efforts.

9. *Nuclear Engineering and Science Congress.* The Executive Board *voted* not to have an ASEE luncheon or dinner during the Congress being held in Philadelphia, Pennsylvania, on March 10-16, 1957.

10. *Future Meetings.*

a. Spring. The meeting of the Executive Board has not yet been integrated with the program of the Ohio Section on April 26 and 27. The Secretary will inform all members of specific plans as soon as possible.

b. *Annual Meeting.* The Executive Board *voted* to have the usual two dinner meetings, Sunday, June 16, and Wednesday, June 19.

11. *Other Business.*

a. Survey of the Engineering Profession. President Everitt explained the

progress being made, and stated that the Joint ECPD-EJC Committee in its report recommended that constituent societies appropriate as much as $50,000 to initiate the program and develop plans for requesting funds. Two other societies already had allocated $10,000 each. The total cost is estimated to be in excess of one million dollars, and informal discussions indicate that foundations are interested. The Executive Board *voted* to allocate up to $1,000 from the Reserve for Special Projects for initiation of the survey, subject to favorable action on the part of other constituent societies of ECPD and EJC, and provided that contributions of societies be determined on the proportionate share basis used in normal budgeting for dues.

b. Ethics Committee Report to the General Council. The Secretary reviewed the actions taken at the Annual Meeting and intervening developments. Copies of "Recommended Recruiting Practices and Procedures," as adopted by the Midwest College Placement Association at its meeting on September 11, 1956, were distributed; the Ethics Committee will recommend it to the General Council for adoption on October 27, 1956. This report is in lieu of the ECAC resolution and is to replace the present "Code of Ethics on Interviewing Procedures" published by the Society. It was agreed that all members should study the "Recommended Practices" before the General Council meeting.

c. Incorporation Papers. Vice President Brown stated that one set of incorporation papers is not entirely in agreement with all provisions of the Constitution and wondered if agreement were necessary. It was agreed the Secretary should send him a copy of later incorporation papers and investigate the necessity for agreement.

d. Summer Teaching for the Secretary. It was agreed that if the University of Illinois-NSF eight-week summer program for young engineering teachers covering topics in resistance of materials developed, the Secretary would be permitted to participate by teaching a graduate course.

12. The meeting adjourned at 10:00 p.m.

Respectfully submitted,
W. Leighton Collins
Secretary

AERONAUTICAL DIVISION MEETING

The ASEE Aeronautical Division will hold its annual joint meeting with the Institute of the Aeronautical Sciences at the IAS annual meeting, New York, New York, the week of January 28, 1957. All members of the Aero Division are cordially invited.

MINUTES OF THE GENERAL COUNCIL MEETING

Detroit, Michigan

October 27, 1956

A breakfast meeting of the General Council of the American Society for Engineering Education was held in the Ivory Room of the Statler Hotel in Detroit, Michigan, at 7:30 A.M. on Saturday, October 27, 1956. President W. L. Everitt presided. Those present were:

Name	*Representing*
W. T. Alexander	Vice President
H. H. Armsby	National Capital Area Section
N. H. Barnard	Kansas-Nebraska Section
G. F. Branigan	Missouri-Arkansas Section
C. A. Brown	Vice President
R. S. Burington	Mathematics Division
R. M. Campbell	Upper New York-Ontario Section
N. A. Christensen	Graduate Studies Division
W. Leighton Collins	Secretary
Renato Contini	ECRC Secretary
E. T. Donovan	New England Section
N. W. Dougherty	Past President
V. L. Doughtie	Southwest Section
C. G. E. Downing	Agricultural Engineering Division
W. L. Everitt	President
Harold Flinsch	Southeastern Section
C. J. Freund	Chairman, Ethics Committee
C. O. Frush	Mineral Engineering Division
John Gammell	Treasurer
F. A. Heacock	Engineering Drawing Division
A. R. Hellwarth	Relations With Industry Division
J. W. Howe	Mechanics Division
C. S. Jones	Technical Institute Division
H. K. Justice	Ohio Section
E. K. Kraybill	Educational Methods Division
A. Lesser, Jr.	Engineering Economy Division
F. C. Lindvall	Vice President
E. C. McClintock, Jr.	Editor
W. G. Murphy (for A. B. Drought)	North Midwest Section
B. H. Norem	Industrial Engineering Division
R. G. Owens	Illinois-Indiana Section
D. J. Peery	Aeronautical Engineering Division
R. L. Peurifoy	Civil Engineering Division
J. H. Pitman	English Division
L. A. Richardson	Architectural Engineering Division
C. E. Schaffner	Evening Engr. Educ. Div.
W. I. Short	Allegheny Section
D. G. Stillman	Humanistic-Social Division
R. W. Van Houten	Middle Atlantic Section
R. J. Woodrow	Vice President

1. *Corrections to Minutes of June 25 and 29, 1956.* The General Council *voted* to approve the following corrections:

a. Item 29c, 2nd paragraph, "ECRC" should be "ECAC."

b. Item 18b, "the new chairman of the Engineering Economy Division" should be "Representative of the Pacific Southwest Section."

c. Add "W. M. Richtmann, Rocky Mountain Section" to those present on June 29.

2. *Report of the Secretary,* W. Leighton Collins

a. *Drop of Members for Nonpayment of Dues.* In accordance with the provisions of the Constitution, the General Council *voted* to drop from membership, as of July 1, 1956, those who were two years in arrears in dues payments at the beginning of the fiscal year and whose names were on the "address unknown" list, but not on the "drop list," as submitted at the 1956 Annual Meeting. The names are in Appendix "A."

b. *Life Membership Requests.* The General Council *voted* to grant life membership to 17 members who met the requirements of the Constitution. The names are in Appendix "B."

c. *YET Paper Contest.* The rules for participation were mailed in the latter part of September (earlier than in the past) and work on the rules for judging is progressing. The latter will be distributed to all Sections as soon as they become available in order that they can be used this year.

3. *Report of the Treasurer,* John Gammell

a. *Annual Audit.* Copies had been mailed to all members and the acceptance by the Executive Board was announced.

b. *Quarterly Statement.* Distributed for informational purposes.

c. *Investment of Society Funds.* Two additional savings accounts of $7,500 each were announced.

4. *Reports of Vice Presidents.*

a. *ECAC,* W. T. Alexander. The work of the various committees and plans for the Annual Meeting program were briefly reviewed. It was reported that one meeting with representatives of the Navy Department to discuss NROTC credit had been held. It was agreed that as soon as an agreement was reached it should be published immediately in an ECAC Bulletin.

b. *ECRC,* R. J. Woodrow. The work of the various committees was briefly summarized. The information and nomination sheets for the Bendix and McGraw Research awards are about ready to go to the printer; both awards will be made in June. The Survey of Research Capabilities under the direction of E. A. Walker is getting under way; personal interviews as well as a questionnaire probably will have to be used. Work on the 1957 edition of the Review of Current Research and Directory of Member Institutions has been started.

c. *Sections and Branches,* F. C. Lindvall. The forms for the annual report of Sections is about ready for mailing. A plea was made that Section representatives see that the forms are filled out and returned, as instructed on the form. All Sections have now selected a YET sub-chairman and appointed liaison members to the Relations With Industry and Physics Divisions.

d. *Divisions and Committees,* C. A. Brown. The discussions at the meeting of Division representatives on Friday afternoon were summarized. These dis-

cussions, like the letter sent to all Division and committee chairmen, stressed improvement of the Annual Meeting programs — more joint meetings, more audience discussion, and less reading of papers. In addition, strengthening of Divisions was stressed by having a vice chairman and executive committee and by having the General Council representative regularly report to the Division on the work of the Council. The desirability of liaison with educational committees of professional societies in the same area also was discussed.

5. *Report of the Editor,* E. C. McClintock, Jr. The reasons for the lateness of issues of the JOURNAL were reviewed as resulting from a dearth of publishable material, a lack of capacity of the printer to handle two issues in one month, factors inherent in any change of editorship, and the training of new assistants. The continued help of everyone, particularly Division officers, is indicating an adequacy of material, and two issues of the JOURNAL are being printed by supplementary facilities to help solve the capacity shortage.

Of the three issues sent to press in early August, the September issue is ready for mailing, October galleys have been returned to the printer in page proof form, and the galleys for November have not been received. The December material is already in the hands of the additional printer, and material for January is being assembled. The alphabetical, geographical, and occupational listings for the February (Yearbook) issue have been mailed to Lancaster Press, so almost all of that issue is in process.

Other major problems are the low rates for advertising in the JOURNAL, and the need for a study of the number and spacing of issues to reduce or eliminate future production difficulties.

6. *Report of Committee on Improvement of Society Functions.* None submitted.

7. *Report of Committee on Constitution and By-Laws,* C. A. Brown, Chairman. Thirteen changes, Appendix "C," were read and discussed. The General Council *voted* to approve changes No. 1, 2, 3, 5, 6, 7, 10, 11, 12, and 13 as presented.

The General Council *voted* to approve change No. 4 with "as defined by the Executive Board" inserted in the second sentence after "Western part."

It was agreed the time schedule in change No. 8 was too tight and that flexibility should be increased by changing expressions such as "to be printed in the first issue of the JOURNAL OF ENGINEERING EDUCATION" in the first sentence to "furnished at the beginning of." The General Council *voted* to approve change No. 8, provided the chairman of the Committee incorporates the suggested editorial changes.

Suggested alterations for change No. 9, Section 2, were: (1) insert "Annual" after "Divisional" in the first sentence, (2) insert "and the National Society" after "Divisions" in the first sentence, and (3) insert "waive property rights of the Society and to" after "authority to" in the last sentence. The General Council *voted* to approve change No. 9 provided the Chairman of the Committee incorporates the alterations suggested.

8. *Report of the Committee on Degree Designations,* J. H. Sams, Chairman. The report was presented by the Secretary, and is attached as Appendix "D." The General Council *voted* to accept the report and instruct the Chairman to submit the suggested article for publication in the JOURNAL OF ENGINEERING EDUCATION. The Committee was not discharged, as requested.

9. *Report of ECAC Committee On Relations With Secondary Schools,* J. F. D. Smith, Chairman. President Everitt received a request from the National Committee for the Development of Scientists and Engineers (of which he is a member) for ASEE-approved suggestions for a "long-range improvement program in science teaching for secondary schools" and referred the request to the Committee. Vice President Alexander read a revision of the draft previously mailed to members of the General Council. The report was discussed in detail and editorial revisions were suggested. The General Council *voted* to adopt the report in principle and instructed the President to refer the report back to the Committee for editing, taking into consideration the suggestions made. It was agreed that the edited report should be printed in the JOURNAL OF ENGINEERING EDUCATION.

10. *Report on International Relations.* H. K. Justice, representing the Society on EJC's International Relations Committee, briefly reviewed the work of that committee. He further stated that he believed the work of ECAC's International Relations Committee should be coordinated with those of EJC. He also stated that a UPADI Conference had been held recently and that a proposal for a new Pacific Federation of Engineering Societies has been made.

11. *Report of Ethics Committee,* C. J. Freund, Chairman. As a result of some recent recruiting practices noted in the resolution submitted by ECAC to the General Council at the Annual Meeting and referred to the Ethics Committee, there is a great need for revising the "Code of Ethics of Interviewing Procedures," published by the Society in 1949. The Ethics Committee had a representative at the recent meeting of the Mid-West College Placement Association (MWCPA). Their interest resulted in Appendix "F," a revision of ASEE's booklet, and in the recommendation that ASEE do something immediately to exert a measure of control over this year's recruiting. The General Council *voted* that the MWCPA code be accepted, that an introduction be prepared by the Ethics Committee, and that the Committee be given power to act without further reference to the General Council. This means that a new ASEE Code based on the MWCPA recommendations will be published as soon as possible, acknowledging the aid of MWCPA. Vice President Alexander considered this action is a highly satisfactory substitute for the resolution originally submitted by ECAC.

12. *Confirmation of Executive Board Approval for the 1957 Program of the Atomic Energy Education Committee.* The Secretary reviewed the three proposals, items 8b and 8c of the minutes of the meeting of the Executive Board, September 15, 1956. Briefly, they are:

1. A summer institute on nuclear energy for 100 college teachers; this will be similar to the ones held last year at Argonne and Brookhaven National Laboratories.

2. A summer institute for 100 college teachers in various areas of specialization; those who attended last summer's institutes or who have equivalent backgrounds would be eligible to attend.

3. A survey of manpower in educational institutions; this would be similar to surveys conducted by the Atomic Energy Commission covering industry and in governmental organizations. The General Council *voted* to confirm the

Executive Board approval of the three programs mentioned above.

13. *Procurement and Training of New Faculty Members.* President Everitt reviewed the proposal, stating that the Executive Board, at its meeting on September 15, 1956 had authorized him to proceed with the formation of a committee and that the proposal be recommended favorably to the General Council for approval. It is believed that the major problem now confronting the colleges of engineering in the United States is the procurement and training of new faculty members to meet the demands resulting from increasing enrollments. The demand for engineers in industry and governmental organizations also complicates the situation. It is believed the problem can be solved only by means of a thorough study of the procurement and development sources, and of methods of getting the best staffs possible in the next ten years; quality, quantity, and general preparation all must be considered. President Everitt stated that after informal discussions with most members of the Executive Board he presented the proposal to Dean H. L. Hazen of the Massachusetts Institute of Technology and asked him to accept the chairmanship if the project was approved. Dean Hazen accepted. It is believed the budget probably would be on the order of $50,000-$100,000, that a foundation needs to be approached for a grant, that the committee needs to prepare objectives, program, and budget, and that high-level people with realistic vision from a variety of areas need to be on the committee.

The General Council *voted* to approve a special study of the Procurement and Training of New Faculty Members.

14. *Mid-Winter Meetings.* The Secretary urged that each member of the General Council publicize the following at Section and other meetings of interested individuals:

a. Cooperative Engineering Education, Northeastern University, January 10-11, 1957.

b. Drawing, Rice Institute, January 31 and February 1, 1957.

c. College-Industry Conference (Relations With Industry), University of California at Los Angeles, January 30-31, 1957.

15. *Summer Schools for 1957.* The status of the following proposals were discussed.

a. Civil Engineering, Surveying, August 5-9, 1957 at Washington State College Summer Camp, Camp Welch, Naches, Washington — plans progressing.

b. YET — delayed for one year due to lack of a feasible plan and some disagreement over the type of specific program desired.

c. English — request withdrawn because the Survey of English in Colleges of Engineering has not yet materialized.

d. Humanistic-Social — postponed one year because time was inadequate for developing a program to request NSF funds for the summer of 1957.

16. *Annual Meetings.*

a. 1957 — Cornell, June 17-21. Committees are already busy.

b. 1958 — California (Berkeley), June 16-20. Enthusiasm is high.

c. 1959 — A decision on the request of the Allegheny Section, Carnegie Institute of Technology and University of Pittsburgh, to have the meeting in Pittsburgh instead of at Purdue University, as previously agreed upon, is expected at any moment. (Note: — Immediately after the meeting it was

learned that Purdue University graciously has agreed to withdraw in favor of Carnegie and Pittsburgh, provided the 1960 meeting could be assured at Purdue. Such assurance was given.)

17. *Reports from Other Committees.*

a. A. R. Hellwarth, chairman of the RWI Division committee, which submitted the report on Migration of Faculty to Industry at the June 1956 meeting, stated that in accordance with the recommendation of the General Council for further study of the problem he had consented to serve as chairman of the new Society committee. He said a committee of the Pacific South West Section is questioning those who left teaching for their reasons and that this was one basis for further study of the problem.

18. *Reports from Other Divisions* — None

19. *Reports from Sections.*

a. On behalf of the Upper New York-Ontario Section, R. M. Campbell expressed a willingness to help Cornell in every way possible and invited those attending the Annual Meeting at Cornell to visit the other colleges of engineering in that area. He also reported that the UNY-O Section had started a study of Technical Institute Education in New York State and submitted to the Secretary a copy of its "Kilcawley Report," along with several recommendations for the inclusion of this program in the Society's current study of technical institutes.

20. *Next Meeting.* The General Council *voted* to meet at Cornell University on:

Monday, June 17 — dinner meeting with wives

Friday, June 21 — luncheon meeting

21. *Other Business*

a. *Study of Technical Institute Curricula.* President Everitt stated that the National Committee for the Development of Scientists and Engineers requested that, "ASEE establish within its framework an organizational unit to stimulate cooperation between industry and technical schools for the purpose of continuous development and improvement of curricula." The problem was discussed with both the Technical Institute and the Relations With Industry Divisions. In accordance with those discussions, the General Council *voted* that the President appoint a joint committee of members of the Technical Institute and Relations With Industry Divisions to study the problem and submit a report to President Everitt for transmission to the National Committee for the Development of Scientists and Engineers.

b. *Model Registration Law.* The National Society for Professional Engineers has prepared a model registration law and is requesting various engineering societies to study the proposal and have a representative present at the NSPE annual meeting to discuss changes and modifications. The General Council *voted* that the President appoint an ad hoc committee to act for the Society, and that the chairman of the Committee attend the NSPE meeting if at all possible.

c. *Resolution of Technical Institute Division.* C. S. Jones stated that the Technical Institute Division was greatly concerned about Senate Bill 4301 introduced in the 84th Congress. This bill, allocating millions of dollars to the states, apparently would place the control of all "less than college degree" education under State Boards of Edu-

cation. This seems to imply that technical institute education would be offered by vocational schools and not by colleges. The Technical Institute Division is opposed to this and consequently adopted the following resolution to be presented to the General Council.

RESOLUTION

WHEREAS Senate Bill 4301 has been introduced into the 84th Congress to make available federal funds for the support of technical education in area vocational schools, and

WHEREAS these proposed schools would be created to extend vocational education into higher educational areas, and

WHEREAS the provisions of this bill would place the administration and direction of post high school educational programs upon educators not experienced at higher academic levels, and

WHEREAS the great need of American Industry and the national economy is for more highly trained persons with technical and engineering competence rather than vocational skills,

BE IT RESOLVED that the Technical Institute Division of the ASEE oppose the adoption of this bill in its present form and urge further studies to determine a more effective method of accomplishing the purposes of the bill, and

BE IT FURTHER RESOLVED that this resolution be presented to the General Council of the Society for their consideration and support.

The General Council *voted* to refer the resolution to the Federal Legislation Committee for study, the Committee to report back to the Executive Board plans for action.

d. *Manual On Consulting Practice.* The Secretary reported that EJC has a committee revising their Manual On Consulting Practice and that C. W. Muhlenbruch represents ASEE. The work has progressed to such a point that Mr. Muhlenbruch needs further instructions. The General Council *voted* that when the manuscript is completed it be submitted to the Executive Board for approval on behalf of the Society.

e. *Survey of the Engineering Profession.* President Everitt reviewed the project and stated that the Executive Board has allocated up to $1,000 for the initiation of the survey.

22. The meeting adjourned at noon.

Respectfully submitted,
W. Leighton Collins
Secretary

PLAN FOR THE ANNUAL MEETING

CORNELL UNIVERSITY

JUNE 17-21, 1957

ITHACA, NEW YORK

Appendix "A" of Council Minutes

MEMBERS WHOSE ADDRESSES ARE UNKNOWN AND WHO SHOULD BE DROPPED, AS OF 1 JULY, 1956, FOR NON-PAYMENT OF DUES FOR TWO OR MORE YEARS

Cavins Baughman	Harry E. House	H. M. Rustebakke
Roland W. Boughton, Jr.	James H. Johnson, Jr.	N. W. Ryan
W. J. Brown	W. A. Johnson	Joseph E. Sayre
George E. Bruchfield	Oliver N. Johnsrud	Raymond Schneyer
Fred P. Burns	C. M. Loyd	R. L. Sloane
John Butkus	S. L. Mikhail	George Sonnemann
Yi-Chung Chang	E. A. Miller	Jasper D. Strickland
John F. Cleary	James Z. Millian	Henry W. Strong
M. M. Ducody	Adrian J. Morgan	John J. Turney
John G. Frayne	Elmo E. Moyer	R. F. Turpin
Samuel D. Hathaway	Daniel J. Murphy	John M. Vickers
R. L. Hightower	O. B. Noren	Raymond V. Von Steenburgh
Robert W. Hippe	Stephen J. Polcyn	Herbert L. Webster
William Horblit	Karl W. Reber	J. W. Zeller

Appendix "B" of Council Minutes

MEMBERS REQUESTING LIFE MEMBERSHIP

F. C. Bolton	Erich Hausmann	Harry W. Rubey
J. Ansel Brooks	L. W. Hitchcock	Edward J. Squire
Hardy Cross	Clarence C. Knipmeyer	O. L. Stock
John N. Eckle	O. W. Kowalke	L. L. Vaughan
Louis E. Endsley	Edgar MacNaughton	Frank M. Warner
Boynton M. Green	C. W. Ricker	

Appendix "C" of Council Minutes

CHANGES IN CONSTITUTION AND BY-LAWS

(Amended in accordance with the changes voted by the General Council and stated in the minutes.)

No. 1 — Article II, Membership

Present

Section 6. The name of each candidate for active individual membership shall be proposed in writing to the Secretary by two members of whom the candidate is personally known. The proposal shall state the qualifications on which it is based. An affirmative letter ballot of three-fourths of those members of the *General Council* whose votes reach the Secretary within one month from the time of sending out the name of the candidate shall elect.

Proposed

Section 6. The name of each candidate for active individaul membership shall be proposed in writing to the Secretary by two members to whom the

candidate is personally known. The proposal shall state the qualifications on which it is based. An affirmative letter ballot of three-fourths of those members of the *Executive Board* whose votes reach the Secretary within one month from the time of sending out the name of the candidate shall elect.

No. 2 — Article II, Membership

Present

Section 7. Institutional members shall be of three classes: Active, Associate, and Affiliate. Active members shall be institutions which are eligible to participate in either or both of the institutional membership Councils. Associate members shall be professional organizations of engineers, research institutions, *and industrial associations or organizations which have a major interest in engineering education.* Affiliate members shall be other educational institutions engaged in technical instruction which have one or more curricula accredited by Engineers' Council for Professional Development or which are accredited by a major regional educational association.

Proposed

Section 7. Institutional members shall be of four classes: Active, Affiliate, Associate, and *Industrial.* Active members shall be institutions which are eligible to participate in either or both of the institutional membership Councils.

Affiliate members shall be other educational institutions engaged in technical instruction which have one or more curricula accredited by Engineers' Council for Professional Development or which are accredited by a major regional educational association. Associate members shall be professional organizations of engineers and research institutions. *Industrial members shall be industrial organizations which have a major interest in engineering education.*

Present

Section 11. The Executive Board shall determine the eligibility of the applicant for membership of any class in the Society. The Executive Board shall have the power to elect Associate and Affiliate members of the Society by letter ballot, but shall refer applications for Active membership to the Executive Committee of each of the Councils in which the applicant desires to participate, each such Executive Committee being empowered to admit the applicant to the Council which it represents. All elections shall require a two-thirds favorable vote of the ballots cast. Institutions thus elected to membership in either or both of the institutional Councils thereby become Active institutional members of the Society.

Proposed

Section 11. The Executive Board shall determine the eligibility of the applicant for membership of any class in the Society. The Executive Board shall have the power to elect Affiliate, Associate, and *Industrial* members of the Society by letter ballot, but shall refer applications for Active membership to the Executive Committee of each of the Councils in which the applicant desires to participate, each such Executive Committee being empowered to admit the applicant to the Council which it represents. All elections shall require a two-thirds favorable vote of the ballots cast. Institutions thus elected to membership in either or both of the institutional Councils thereby become Active institutional members of the Society.

No. 3 — Article III, Organization

Present

Section 2. The individual members of the Society shall further be organized in groups to function as (a) sections in specified territories; (b) branches formed by members of single institutions and (c) divisions with important subjects of instruction or research, under provisions as hereinafter set forth.

Proposed

Section 2. The individual members of the Society shall further be organized in groups to function as (a) sections in specified territories; (b) branches formed by members of single institutions and (c) divisions with important subjects of instruction, research, or *activity related to engineering education,* under provisions as hereinafter set forth.

No. 4 — Article IV, Officers

Present

There shall be a President, who shall be the executive officer of the Society and who shall hold office for one year. There shall be four Vice Presidents, each to hold office for two years, as follows: In connection with the individual membership, a Vice President responsible for General and Regional Activities, and a Vice President responsible for Instructional Divisions, to be elected in alternate years; in connection with institutional membership, a Vice President responsible for the Engineering College Research Council, and a Vice President responsible for the Engineering College Administrative Council, to be elected in alternate years. There shall be a Secretary, to be appointed annually by a Committee consisting of the President and all Vice Presidents; and a Treasurer, to be elected annually. In case of a vacancy in office of the President, the Vice President for General and Regional Activities shall succeed to that office. In case of a vacancy in the office of the Vice President for General and Regional Activities, the Vice President for Instructional Divisions shall succeed to that office.

Proposed

There shall be a President, who shall be the executive officer of the Society and who shall hold office for one year. There shall be *six* Vice Presidents, each to hold office for two years as follows: in connection with individual memberships, *two* Vice Presidents responsible for General and Regional Activities, *one in the Eastern part of the United States and one in the Western part,* as designated by the Executive Board, to be elected in alternate years: a Vice President for Instructional Divisions and Committees and a *Vice President for General Divisions and Committees* to be elected in alternate years. In connection with institutional memberships, there shall be a Vice President responsible for the Engineering College Research Council and a Vice President responsible for the Engineering College Administrative Council, to be elected in alternate years. There shall be a Secretary, to be appointed annually by a committee consisting of the President and all Vice Presidents; and a Treasurer, to be elected annually. In case of vacancy in the office of the President, the *senior* Vice President for General and Regional Activities shall

succeed. In case of a vacancy in the office of Vice President for General and Regional Activities, the *senior* Vice President for Instructional Divisions shall succeed.

No. 5 — Article V, Executive Board

Present

Section 1. The Executive Board of the Society shall consist of the President, the four Vice Presidents, the Secretary, and the Treasurer. Its function shall be to coordinate the activities of the Society. Its actions shall be final as to (a) approval of budgets, (b) authorization of publications, (c) conventions, (d) appointment of officers to fill emergency vacancies, and (e) determination of eligibility of institutional members. In all other matters, however, the Executive Board is advisory to the General Council, the Engineering College Research Council, and Engineering College Administrative Council.

Proposed

Section 1. The Executive Board of the Society shall consist of the President, the *six* Vice Presidents, the Secretary, and the Treasurer. Its function shall be to coordinate the activities of the Society. Its actions shall be final as to (a) approval of budgets, (b) authorization of publications, (c) conventions, (d) appointment of officers to fill emergency vacancies, (e) determination of eligibility of institutional members, and (f) *actions of the Society in relation to other organizations. The Executive Board is responsible for the general supervision and control of all financial matters in which the name of the Society is used.* In all other matters, however, the Executive Board is advisory to the General Council, the Engineering College Research Council, and the Engineering College Administrative Council.

No. 6 — Article VI, General Council

Present

Section 1. The General Council of the Society shall consist of the President, who shall be chairman, the four Vice Presidents, the Secretary, the Treasurer, and the three Junior Past Presidents and a representative of every Division and Section elected by the body concerned for a term of two years according to a plan of rotation in which one half of such representatives will be chosen each year.

Proposed

Section 1. The General Council of the Society shall consist of the President, who shall be chairman, the *six* Vice Presidents, the Secretary, the Treasurer, the three Junior Past Presidents, *the secretaries of the Engineering College Research Council and the Engineering College Administrative Council,* and a representative of every Division and Section elected by the body concerned for a term of two years according to a plan of rotation in which one half of such representatives will be chosen each year.

No. 7 — Article X, Election of Officers

Present

Section 1. The President, Treasurer, and two Vice Presidents, who must be members of the Society, shall be elected at the annual meeting by ballot of the individual membership present. The President and Treasurer shall be elected annually and the two Vice Presidents associated with individual membership shall be elected in alternate years for respective terms of two years. The two Vice Presidents associated with institutional membership shall be elected at the annual meeting of the Society in alternate years for respective terms of two years by their respective councils.

Proposed

Section 1. The President, Treasurer, and *four* Vice Presidents, who must be members of the Society, shall be elected by *mail ballot of the individual membership.* The President and Treasurer shall be elected annually. *The two Vice Presidents for General and Regional Activities shall be elected in alternate years. The Vice President for Instructional Division and Committee Activities and the Vice President for General Divisions and Committees shall be elected in alternate years.* The two Vice Presidents associated with institutional membership shall be elected at the annual meeting of the Society in alternate years for respective terms of two years by their respective councils.

No. 8 — Article X, Election of Officers

Present

Section 3. By means of a form to be printed in THE JOURNAL OF ENGINEERING EDUCATION or in the preliminary program of the annual meeting, an opportunity shall be given to individual members of the Society to submit names of persons to be considered for said officers. These names, on the form provided, shall be sent to the Secretary of the Society not less than sixty (60) days prior to the annual meeting; and the Secretary shall submit the suggested names to all members of the Nominating Committee.

Proposed

Section 3. By means of a form furnished at the beginning of *each academic year,* an opportunity shall be given to individual members of the Society to submit names of persons to be considered for nomination. These names, on the forms provided, shall be sent to the Secretary of the Society not less than *thirty (30) days prior to the fall meeting of the General Council.* The Secretary shall submit the suggested names to all members of the Nominating Committee. *At the time of the fall meeting of the General Council, the Nominating Committee shall select candidates whose names shall be made available to the entire membership in December or January. After the publication of the nominees proposed by the Nominating Committee, other nominations may be made by petition of 50 signatures of members of the Society in good standing. Each nominee must have indicated his willingness to serve if elected before his name can be placed on the ballot. In February or March, ballots giving the names of all*

candidates will be provided. Ballots received by the Secretary by March 31 shall determine the election of the officers as of April 1. Their terms of office shall begin ten days after the date of the annual meeting.

No. 9 — Article IX, Sections, Branches, and Divisions

Present

Section 3. Papers and discussions presented before Sections or Branches shall be the property of the Society and may be published as Society proceedings if authorized by the Publication Committee. Permission to publish such papers and discussions elsewhere may be granted by the Executive Board of the General Council on condition that the Society receives proper credit.

Note: This section as revised to become Section 2 of Article XIII, Publications, Sections 4 and 5 of this article to be renumbered 3 and 4 respectively.

Proposed

ARTICLE XIII, PUBLICATIONS

Section 1. The Executive Board shall authorize all official publications of the Society and shall also prescribe the rights of the several grades of members in connection with these publications.

Section 2. Papers and discussions presented before Sectional, Branch, *Divisional or Annual* meetings or *submitted in contests in Section, Branches, or Divisions and the Society at large* shall be the property of the Society and may be published as Society proceedings if authorized by the Publications Committee. The *Secretary* shall have authority to *waive property rights of the Society or to* grant permission to publish such papers and discussions elsewhere on condition that the Society receives proper credit.

No. 10 — By-Law No. 7

Present

Seventh. Committees, excepting the Executive Committees, reporting to the Executive Board and to the General Council shall be authorized by these respective bodies and appointed by the President. Committees reporting to either of the Institutional Councils shall be authorized by the Executive Committee concerned and be appointed by the Vice President concerned. Committees of Sections, Branches, or Divisions shall be authorized by the body concerned and be appointed by the Chairman of the body concerned.

Proposed

Seventh. Committees reporting to either Institutional Council shall be authorized by the Executive Committee concerned and be appointed by the Vice President concerned. Committees of Sections, Branches, or Divisions shall be authorized by the body concerned and be appointed by the Chairman of the body concerned. *The Awards Committee, the Membership Committees, the Financial Policy Committee, the Publications Committee, the Public Relations Committee, and the Constitution and By-Laws Committee are*

appointed by the President and are responsible to the Executive Board. Other standing committees and committees for special projects authorized by the Executive Board and General Council shall be appointed by the President with staff responsibility designated to the appropriate Vice President.

No. 11 — By-Law No. 8

Present

Eighth. There shall be a Publications Committee consisting of the President, junior Past President, and the Secretary of the Society who shall be chairman. It shall be responsible to the Executive Board for the general administration of all official publications of the Society.

The Secretary of the Society shall have direct charge and be editor of all publications authorized by the Executive Board excepting those so authorized for the Engineering College Research Council and the Engineering College Administrative Council, which shall be edited and published in accordance with plans of procedure recommended by these respective Councils and approved by the Executive Board; provided, however, that the plans shall include a subcommittee to be recommended by the Council concerned and approved by the Executive Board.

The selling price of all publications shall be determined by the Executive Board on recommendation of the Publications Committee.

All income from publications shall be classified as income of the Society applicable to the annual budget of the Society.

Proposed

Eighth. There shall be a Publication Committee consisting of the President, the junior Past President, *the Editor (appointed by the Executive Board), the Chairman of the English Division (ex-officio), the Secretaries of Engineering College Administrative Council and Engineering College Research Council,* and the Secretary of the Society, who shall be chairman. It shall be responsible to the Executive Board for the general administration of all official publications of the Society.

The *Editor shall be in direct charge of the* JOURNAL OF ENGINEERING EDUCATION. *Publications authorized by the Engineering College Research Council and the Engineering College Administrative Council shall be edited and published in accordance with plans of procedure recommended by these respective Councils and approved by the Executive Board.*

The selling price of all publications shall be determined by the Executive Board on recommendation of the Publications Committee.

All income from publications shall be classified as income of the Society applicable to the annual budget of the Society.

No. 12 — By-Law No. 9

Present

Ninth. These By-laws, excepting as they relate to dues of individual members, may be amended by a two-thirds vote of the members present at any regular meeting of the Society, provided that all individual and institutional members have been notified of

the proposed amendment by notices mailed by the Secretary's Office at least thirty (30) days prior to the said regular meeting at which action is to be taken, and provided further that the proposed amendment has first been voted upon by each of the three Councils of the Society and the results of such vote recorded in the notice sent out for the meeting at which the proposed amendment is to be acted upon.

The dues of individual members may be changed only by a favorable vote by letter ballot of individual members.

Proposed

Ninth. These By-laws, excepting as they relate to dues of individual members, may be amended by a two-thirds vote of the members present at any regular meeting of the Society provided that all individual and institutional members have been notified of the proposed amendment by notices *published in the* JOURNAL at least thirty (30) days prior to the said regular meeting at which action is to be taken, and provided further that the proposed amendment has first been voted upon by *the Executive Board* and the results of such vote recorded in the notice sent out for the meetings at which the proposed amendment is to be acted upon.

The dues of individual members may be changed only by a majority vote received by letter ballot of individual members.

No. 13 — By-Law No. 10

Proposed

10. The Awards Committee is responsible for establishing and coordinating policy, including procedures for presentations, with respect to awards presented in the name of the Society or a constituent part of the Society.

Appendix "D" of the Council Minutes

REPORT OF THE COMMITTEE ON DEGREE DESIGNATIONS

For several years the Committee on Degree Designations has studied the various programs of study offered by the institutions of higher learning in the field of engineering and its related technologies. Last year the committee submitted a report on several programs, which was adopted by the General Council and distributed to the Presidents and to the Deans of the member institutions of ASEE.

The Secretary of the ASEE has received an excellent response from the Presidents and Deans on the report of this committee. Several have asked for clarification and further information on the background for our recommendations. A brief article should be prepared for publication in the JOURNAL in the near future to cover this material. A few have been critical, but it was gratifying to note that the overwhelming majority were in favor of the recommendations. A number of institutions indicated that in cases where their practice did not agree with the recommendations of the committee, steps were being taken to change their degree designations to conform with those suggested by ASEE. Many institutions commended the ASEE for this study to bring about a more uniform

designation of degrees among the engineering colleges in the United States.

After further study of the five year, ten semester, baccalaureate program and the two year terminal graduate program, the committee does not feel that it should recommend a designation for degrees at this time.

The five year baccalaureate program is now offered in several institutions, but each one has a different approach and the requirements for graduation vary considerably. This ten semester program is still in an experimental stage, and will remain so for several years. Until a more definite pattern emerges from the schools concerned, this committee recommends that no action be taken by ASEE to suggest a designation for this program.

The two year terminal graduate program requires more than normally expected for the Master's degree, and is offered primarily for those engineers who plan to go into professional practice as designers and consulting engineers. At the present time very few institutions offer this program and the general pattern varies considerably. Until this program emerges with a more definite pattern and is out of the experimental stage, this committee recommends that no action be taken by ASEE to offer a designation for a degree for this program.

This committee feels that its mission has been accomplished for the present. It therefore requests that it be deactivated by the General Council of ASEE until such time as the need for further study is indicated.

Respectfully submitted;

S. C. Hollister
J. F. D. Smith
K. L. Holderman
H. P. Rodes
L. F. Smith
J. W. Whittemore
James H. Sams, *Chmn.*
T. J. Higgins
H. K. Justice
C. O. Mackey

Appendix "E" of the Council Minutes

ASEE SUGGESTIONS FOR LONG-RANGE IMPROVEMENT PROGRAM IN SCIENCE TEACHING FOR SECONDARY SCHOOLS

The need for additional competent staff to teach science and mathematics in high schools has been mentioned frequently in the public press. Facts are available to demonstrate it conclusively. We in engineering education are particularly concerned with the problem, since some of the sciences, formerly taught in high school, now must be taught in college or university. This delays the completion of the student's formal education. Many of us are also concerned as parents of children who are, or will be, going through the high schools; and we are all concerned for the welfare of the country.

The Secondary Schools Committee of the ASEE has considered the matter, and recommends the following program to the Council of the Society for approval.

Since there is an inadequate supply of high school teachers who can teach mathematics and science, and there is little prospect of filling the needs for some time, we recommend the following courses of action:

1. *Upgrading and Making Better Use of Those Now Teaching*

a. Encourage the retention of more of those qualified to teach mathematics and science in the high schools. This would involve an educational program to persuade industry not to keep hiring the high school staffs. With the present shortage of technical staff in industry considerable salesmanship will be needed. To be effective this would also require an educational program aimed at those responsible for the setting of high school salary scales, which are woefully low, and for the necessity of improving the attitude of the public towards the sciences. It would also require the improvement of the professional and social status of high school teachers.

b. Reduce the extracurricular load of qualified science teachers and give many routine chores to assistants.

c. Upgrade less qualified science teachers by extension courses in the basic subject matter of their field.

d. The American Society for Engineering Education should cooperate with other interested agencies in sponsoring summer school institutes for science and mathematics teachers. Some industries have already operated such institutes, and cooperation should be readily obtained from industry and perhaps from the National Science Foundation. Teachers in science and mathematics sometimes are inadequately trained in the subject matter. Intensive training for such people in summer institutes could be most helpful.

The Society should also explore the possibility of using summer institutes to acquire teacher accreditation.

e. Industry should be encouraged to employ high school science and mathematics teachers in the summers. This increases the income of the teachers, and gives them a wider knowledge of the application of their subject matter in industry. In general, such broadening of training can make the teaching more meaningful.

Industry should not try to use this program as a device for luring teachers to leave teaching permanently.

f. Encourage recognition of outstanding high school teachers in the sciences and mathematics. This is already being done by some professional engineering and architectural groups, and is being considered by the AAAS.

2. *Improvement of Teaching Techniques in High School Sciences*

a. Joint Committees of ASEE and high school science teacher groups could compile descriptive lists of interesting illustrative material in various science fields. This would consist of models and visual aids, and would be somewhat similar to that compiled by the ASEE Committee on Teaching Aids.

b. Encourage experimentation in high school training with the objective of covering the various mathematics and science courses more expeditiously than is customary. For certain students it may be possible to do in four semesters what is ordinarily covered in five. Attempts are under way, for example, to give a combined year of plane and solid geometry. Advice should be given to the high schools regarding what is considered desirable, and what necessary, for admission to a college to study science or engineering. One approach is that proposed by the University of Illinois and already used in that state. (Mathematics Needs of Prospective Students, University of Illinois Bulletin, Vol. 49, No. 9 (1951) and No. 61 (1952).

3. *Recruiting More and Better Qualified Teachers in the Sciences*

a. Encourage those responsible for teacher certification to waive the requirements temporarily for those qualified in the sciences but lacking all the presently required courses in teacher training. Encourage the concurrent training of such people in teacher training, where feasible. This is already permitted in some states.

Among those who may be considered are Army, Navy, Air Force, industry, college, and other educational retirees, where age, energy, and interests seem satisfactory. Proper selection procedures would have to be developed.

In addition, special accelerated programs in education could be prepared for senior college students who wish to qualify for teaching positions the following year.

b. Many industries are sufficiently concerned about the problem to be willing to loan some of their staff to help teach sciences in high schools, but are often barred from doing so because of the teacher certification requirements and the time necessary to handle routine details which could be performed by a teacher's aide. This field should be explored thoroughly.

In addition, we should encourage high school officials to invite outstanding scientists or engineers, from industry or college, to talk to high school students, or faculty, or both, at suitable assembly periods, on the importance of science and mathematics in everyday life.

c. Some colleges may be encouraged to instigate refresher courses in college for retired engineers or scientist so that they may be better prepared for high school teaching.

4. *Recruiting More and Better Students for High School Science Courses*

a. The ASEE should be willing to offer either from among its membership, or through cooperation with industry, guidance counsel to high school students if this is desired by the school officials. In the large schools there are fully qualified guidance counselors, but in some of the smaller schools the school counselor may not have a broad enough knowledge.

b. Encourage programs such as the Future Scientists of America, or JETS.

c. Science and engineering are no longer limited to men. Women in the past have had better opportunities in science than in engineering, as is evident from the number of distinguished women scientists. This is still true, but opportunities for women in engineering are now opening up. Some fields are still unsuitable for women, whereas others are not. The Society should present through whatever agencies it deems proper, that women who would like to pursue careers in science or engineering are not necessarily unfeminine. Such women might also be encouraged to teach in the sciences or in mathematics in high schools.

d. Many of the statements frequently quoted in the press regarding the teaching in the sciences in high school are misleading. For example, it is frequently stated that the percentage of high school students studying chemistry has decreased greatly in recent years. This is correct, but, since 1890, the number of pupils taking chemistry in high schools has increased twenty-fold. Of those presently enrolled in chemistry, 45 per cent are girls. In addition, there is evidence that there is a grow-

ing interest in mathematics among pupils of certain high schools. The Society should encourage the improvement in standards in the high schools. This may require better teaching aids and laboratory equipment. This will cost money, and it should be explained to the proper authorities.

Nevertheless, there seems to be an attitude both among pupils and teachers in high school that the sciences and mathematics are difficult subjects, are unnecessary for everyday living, and can logically be by-passed.

The ASEE should encourage all proper agencies to combat this anti-intellectual attitude. One of the principal functions of the high school should be to train pupils to think for themselves. This can better be done by the study of mathematics and the sciences than by many other subjects, regardless whether the pupil intends to go to college later.

5. *Investigation of Teaching Training Requirements*

a. The scarcity of teachers properly qualified both in knowledge of the sciences and in teacher training has led in many cases to the use of teachers who have teacher training but relatively little knowledge of the sciences. The results have not always been good.

The second possibility is to consider those who have a knowledge of the sciences but have little, or no, knowledge of teacher training. Among such people would be experienced engineers or scientists, either now working or retired, or retired personnel with an adequate technical background and an interest in teaching. There are differing opinions on the amount of teacher training necessary at the high school level. College teachers in the sciences seldom have *any* formal teacher training, and acquire their skill from experience. Unquestionably their teaching could often be improved by proper training. Possibly the need is greater in high school than in college.

Most states require 18-30 semester hours in such areas as teaching methods, student teaching, psychology, and the history of education. New York State requires at least 8 semester hours in professional education courses before a license can be obtained to teach in a secondary school. Unquestionably such training is desirable.

But how much is actually necessary? Some feel that a relatively short period of teacher training would be adequate — others insist on the complete program of method-course and education-course requirements.

Thus encouragement should be given to experiments to determine how much teacher training is really necessary to do an adequate job of teaching the sciences in high school. Controlled experiments might be set up to test the effectiveness, as teachers, of those qualified in subject matter but with little formal training as teachers, as compared with those who have the presently accepted standard of training, and compared with those who have a limited but concentrated course in teacher training.

While there is reasonable certainty that, in general, the formal requirements in education will be required for certification, there is a general feeling that there is not adequate insistence by the same certification authorities for adequate training in subject matter to be taught. The ASEE should encourage insistence on proper training in the subject to be taught.

Submitted by the Secondary Schools Committee of ASEE

R. H. CARLTON R. C. POTTER A. R. SPALDING
H. H. METCALF H. A. ROMANOWITZ E. B. STAVELY
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J. F. DOWNIE SMITH, *Chmn.*

Appendix "F" of the Council Minutes

RECOMMENDED RECRUITING PRACTICES AND PROCEDURES

Adopted by the Midwest College Placement Association September 11, 1956

After editing, this will replace the 1949 Code of Ethics. When available, copies may be purchased from the Secretary's office.

Responsibility of Employer

1. It shall be the responsibilty of the employer to contact the colleges early enough so that the schools can plan to take care of those organizations who wish to interview their students. Due to the limited number of companies that can be handled at one time on the campus, it is necessary to carefully schedule arrivals and interviews. In the original request for interview dates it is imperative that indication be made of the number of separate interview schedules desired.

2. At the conclusion of the interview the student should be informed by the interviewer what the exact step will be or that there is no mutual interest.

3. All organizations should give the students ample time to objectively consider the employment offer before requiring a final answer.

4. The employer should provide written material which will give the student a real picture of the company, such as the Company Information Sheet or similar material preparing the student for the interview. This information should be supplied to the placement office in adequate quantity. The student should be clearly informed by the employer if he will be expected to take psychological, aptitude or other tests before being accepted for a job. Other clarification should include reference to the signing of patent agreements, passing of physical examinations and other incidents to final acceptance.

5. The employer should inform the placement officer of broad categories of employment possibilities and the particular degrees desired.

6. The employer has, as part of the overall educational plan, the responsibilty of guidance and assistance to students. It is therefore recommended that interviews be conducted regularly, year after year.

7. Dates suggested by the employer for plant visits should be flexible so as to cause the least interference with classroom schedules. This invitation to visit the employer's plant should indicate what expenses the company will pay and how and when reimbursement will be made. (Many students borrow money to make these trips). If more than one company is visited during the same trip the expenses should be prorated. (see attached simplified expense sheet for listing allowable expenses less the amount paid by other organiza-

tions).* Elaborate entertainment and other overselling techniques should be avoided.

8. Placement offices should receive carbon copies of all correspondence with students and faculty members.

9. The employer should recognize the necessity of punctuality. He should advise the placement office or faculty of his expected arrival time, arrive as agreed and maintain his interviewing schedule. The practice of requesting psychological and other testing services by the placement office should be discouraged.

10. It is recommended practice to have not more than two representatives for each interview schedule. One is preferred.

11. An employer who desires to contact a particular individual at the time of his interviewing visit should write that individual with a copy to the placement office at least two weeks in advance.

12. An employer should not offer a student any special payment or salary arrangement which is not already a part of his company's salary program. Gifts, bonuses and other inducements for which the student has not worked are basically wrong. Any attempt to hurry the student's decision beyond normal reasonable limits or to benefit a third party due to relationships with the student is wrong.

13. The reopening of a job offer to a student who has rejected it should only be done through the placement office. This procedure protects the company from interfering with the student who has accepted another offer.

14. The employer should recognize that it is bad practice not to honor all offers which have been accepted.

* Not included in this Appendix.

Responsibility of the College

1. Placement offices and faculties should as early as possible send data to employers indicating the approximate number of students who will be available for interviews during the school year. This information should include dates of graduation and should be arranged by courses.

2. It is strongly recommended that no restrictions be placed on the number of interviews a student can take except that indiscriminate or general "shopping" should be discouraged.

3. The schools should provide adequate physical facilities for the conducting of interviews. The placement office should control the distribution of the company literature. The schools should provide space so that the interview can be conducted quietly and in private.

4. At the beginning of the school year the placement office should make known to the students the organizations planning to visit the school and make the necessary revision announcements from time to time.

5. It should be the school's responsibility to provide contact with faculty members who have knowledge of the student and his work. These periods of contact should be conducted during the regular school hours.

6. The appropriate school records on students interviewed should be available to the employer.

7. When an organization is looking for several categories of students, it should be the responsibility of the placement office insofar as it is possible to see that there is available for them to interview an adequate distribution from various programs.

8. Faculty members may advise but should not use undue influence on the students in the selection of a job.

Responsibility of the Student

1. In anticipation of an interview with an organization, the student should prepare himself properly by reading literature, organizing his own thoughts in order to ask and answer questions, and being as fully informed as possible on the type of business conducted by the organization.

2. He should use care in filling out various forms in preparation for interviews such as the standard College Interview Form.

3. A student should not collect and hoard offers. As soon as a student knows that he will not accept an offer that offer should be *immediately* rejected.

4. The student should keep the placement office or faculty member advised concerning his negotiations.

5. In all interviews he should conduct himself in a business-like manner.

6. On off-campus interviews, only incurred expenses should be included on the expense sheet and these prorated if more than one organization is visited on the same trip.

7. He should not take interviews after he has accepted employment.

8. All invitations for plant visits should be *promptly* acknowledged. Invitations should only be accepted where the student has a sincere interest in permanent employment.

ENGINEERING COLLEGE RESEARCH COUNCIL

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ASEE CALENDAR OF EVENTS, 1956-1957

Meeting	*Date*	*Location*	*Chairman or Information*
Pacific Southwest Section	Dec. 27–28	University of Arizona	D. Whelan, Loyola U. of L. A.
Relations With Industry Division, College-Industry Conference	Jan. 30–31	University of California (Los Angeles)	C. Muhlenbruch, Educational and Technical Consultants
Cooperative Engineering Education Division	Jan. 10–11	Northeastern University	E. Hamlen, U. of Akron
Engineering Drawing Division	Jan. 30–Feb. 1	Rice Institute	I. L. Hill, Ill. Institute of Technology
Missouri-Arkansas Section	April 6	University of Arkansas	L. R. Heiple, U. of Arkansas
Southwest Section	April 18–19	Texas A. & M. College	E. M. Thomas, Texas Western
Allegheny Section	April 26–27	Penn State University	B. A. Whisler, Penn State U.
Ohio Section	April 26–27	University of Toledo	E. D. Harrison, U. of Toledo
Rocky Mt. Section	April 27	Brigham Young University	B. Brown, Brigham Young U.
Southeastern Section	April	University of Kentucky	M. Baker, U. of Kentucky
Michigan Section	May 4	General Motors Institute	C. L. Fanning, General Motors Institute
Pacific Northwest Section	May	Washington State College	M. C. Jenson, Washington State College
Illinois-Indiana	May 17	Northwestern	O. W. Eshbach, Northwestern U.
ASEE ANNUAL MEETING	JUNE 17–21 1957	CORNELL UNIVERSITY	J. C. Gebhard
Kansas-Nebraska Section	October	Kansas State College College	K. Razak, University of Wichita
North Midwest Section	October	Minneapolis, Minnesota	P. Cartwright, University of Minnesota